
HERBERTIA

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Cover Photo: *Boophone disticha* in bloom near Cathcart
following a veld fire, Eastern Cape.
Photo by Cameron McMaster.

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EDITOR'S COMMENTS

The costs of publishing and mailing *Herbertia* continue to escalate, whereas the Society's yearly dues have remained unchanged for the last decade. (Mailing expenses for international members have tripled during the 21st Century.) At the same time, our yearly publication has benefited from printing advances, and now we have a first class journal with an abundance of color photography. Members will note that expense considerations have necessitated the demise of BULBS as a second publication, but at the same time, the issue size of *Herbertia* has expanded as evident by the increased thickness of a single issue.

The Herbert Medalist for 2010 is Dr. Ori Fragman-Sapir of Israel. While a participant on an archeological tour of ancient Israel, I had the fortunate opportunity to meet Dr. Ori in person in June, 2009. He was a most cordial host and gave my wife, a young teenage plant-enthusiast from our tour group, and myself a guided tour of the Jerusalem Botanical Gardens, providing us with detailed accounts of the more interesting plants under cultivation. We were decidedly impressed by both the host and the gardens.

The Board approved Two Traub Awards for 2010, the Awardees being Herbert Kelly, Jr., of Riverside, California, and Robert Thompson of Whittier, California.

We continue to attract quality contributions for our publication. In this issue we have a comprehensive review of the section *Chilensia* of *Tropaeolum* (Nasturtiums) occurring in Chile, complete with a large assortment of field photographs by John Watson and Ana Flores. There is also a review of the genus *Cryptostephanus* from Southern Africa by Graham Duncan, the 2001 Herbert Medalist. Our current Herbert Medalist illustrates a panorama of blooming Israeli desert bulbs. New taxa published in this issue include a new *Ornithogalum* species from Angola, a new *Crinum* species from Australia, a new *Zephyranthes* species from Mexico, and a new nothogenus of Amaryllidaceae. Charles Craib reports on the rediscovery of a long lost *Haemanthus* species. Robert Hamilton entertains with another adventure by IBS plant hunters in Australia. Additional articles address *Prototulbaghia*, *Narcissus*, *Fritillaria*, *Alstroemeria*, and hybridization. Cameron McMaster, who provided the image for the front cover, concludes this issue with a book review.

— David J. Lehmiller, Editor

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THE HERBERT MEDAL



The Herbert Medal is the highest honor that the International Bulb Society can bestow upon a person for meritorious achievement in advancing the knowledge of bulbous plants. The medal is named for William Herbert (1778-1847), son of Henry Herbert, Earl of Carnarvon. William Herbert had a predilection for amaryllids and achieved success in their hybridization. He published his research findings in several monumental works. His contributions as a pioneer geneticist and plant breeder, and his arrangement of the Amaryllidaceae, helped set the stage upon which other workers, both amateur and professional, have been able to advance.

The Herbert Medal may be awarded annually or on special occasions by the Board of Directors of the Society. Candidates for the Medal are recommended to the Board of Directors by the Awards and Recognition Committee. Medalists need not be members of the Society to be considered for the Herbert Medal. The award includes honorary life membership in the Society.

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2010 HERBERT MEDALIST
ORI FRAGMAN-SAPIR



Fig. 1. Pilgrimage to the desert irises, this one is the rare endemic *Iris mariae* in the western Negev Desert, Israel, March 2008. Photograph by Judith Marcus.



Fig. 2. Enjoying and studying the unique flora of Mt Hermon in northern Israel, *Eremurus spectabilis* and Ori at 1500 m. Photograph by Pentti Perttula.



Fig. 3. Ori with puppy. Photograph by (Ori's wife) Vered Sapir-Fragman..



Fig. 4. Taking pictures is a real hobby and also a way of focusing and looking at the plants; the ring flash is a great tool when sunlight is not available. The flower is *Galanthus platyphyllus*, the last blooming snowdrop, Georgia, Greater Caucasus, July 2009. Photograph by Zvika Avni.

ORI FRAGMAN-SAPIR

Biographical Notes

I was born in 1965 in Tel-Aviv, Israel, and had my primary and secondary education in this town. Already as a child I was interested tremendously in nature, in animals and in plants. Although I grew up in the centre of the city of Tel-Aviv, an empty plot of land provided me with an abundance of nature – flowers, insects, mice and birds. After graduating from high school, I joined the army for 3 years; during these years I surveyed nature around me and identified many plants, including bulbs that were new to me.

I studied biology at the Hebrew University of Jerusalem and later obtained my MSc and PhD - my thesis title was Resource Allocation in Geophytes, under supervision of Prof. Avi Shmida and Prof. Jaime Kigel. In this work I compared 17 pairs of bulbs growing in the Mediterranean and in the desert zones of Israel. This study indicated that there were no large differences between the different climatic regions in the above-ground plant organ traits. The differences were dramatic in the weight of the storage organ as a food and water reserve for survival in the dry season and for early flowering and sprouting in the next growth season. Low flowering rates in the desert and under minimal irrigation in experiment, low weight of bulblets compared to flowers weight, and continuous vegetative reproduction in non-flowering plants, indicated that vegetative reproduction was a preferable reproductive alternative in low resource conditions. These latter conditions were more common in the desert region.

Parallel to my PhD years I was managing the Rare Plant Survey in Israel, resulting in a new method to evaluate the vulnerability of plants. After my PhD work I was trained in molecular work at Mainz, Germany, studying the very close and confusing *Oncocyclus* Irises.

Since 2001 I have been the head scientist of the Jerusalem Botanical Gardens. These gardens host more than 10,000 plant species, including a large bulb collection that I have expanded. We are trying to promote species that can have sustainable populations in the garden, such as *Sternbergia clusiana*, *Narcissus serotinus*, *Iris vartanii*, *Iris mesopotamica* and many more. In the past years I have organized several workshops on bulbs, which have taken place in autumn (the main planting season in Israel) or in March (when most bulbs are in bloom); in these workshops the public and professionals are exposed to the common available bulbs as well as the rare wild species

and new cultivated species and hybrids.

Through my work in the garden and in my papers (both scientific and popular) I'm trying to promote the knowledge of plants and especially bulbous species. I'm trying very hard to translate the complicated scientific knowledge into practical knowhow for the general public.

I have submitted many of my bulb photos to the International Bulb Society Website since I always have thought pictures as well as knowledge should be shared rather than saved in one's computer or mind. Another matter that I'm trying to promote in recent years is the connection between growers-horticulturists and naturalists. Too often these two groups are opposing each other rather than collaborating. Such collaboration would benefit both sides.

Writing books is another important issue in my life. I'm writing plant guides for several regions; in all of these the bulbous plants are starring, whether it is a small *Gagea* blooming in the arid slopes of the Dead Sea or a rare *Iris* in the Transcaucasus. Recently I'm involved in writing the Red Data Book on the threatened plants of Israel, hoping that it will promote their preservation in nature and in botanical gardens and shelter gardens.

And back to the bulbous plants – the geophytes – a special group of plants that are so diverse. What is a bulb? This is a tough question. Is it an anemone with a small tuber that is drying in summer, or perhaps a garlic with a wet bulb? And what are really the storing organs - a single scaled bulb of the *Tulip* or *Gagea*? So how can we define exactly the storing organ of the *Colchicum*? Is it much different?

So many questions are unanswered, so many things to investigate, and this is why the bulb world is so intriguing. The bulbs which are actually 'investment banks' – banks of water and nutrients; and the bulb is not only a storing organ, it is also often a reproductive organ. This is why it is so exciting.

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THE HAMILTON P. TRAUB AWARD FOR DISTINGUISHED SERVICE

This award was established in 2000 by the IBS Board of Directors to recognize meritorious service to the Society. It is named after Dr. Hamilton P. Traub, founder of the American Plant Life Society, antecedent of IBS, and editor of its journals for a half century.

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**2010 TRAUB AWARD
HERBERT KELLY JR.**



Fig. 1. Herbert Kelly Jr. holding *Hedychium gardnerianum* (Kahili Ginger) on the Island of Hawaii (Big Island).

**HERBERT KELLY JR.
By David Lehmiller***

The American Amaryllis Society (AAS) came into being in 1934, a plant society largely the brainchild of Dr. Hamilton P. Traub, acknowledged as its founder. Its first annual publication, the Yearbook of the American Amaryllis Society, appeared in 1934 with Traub as its Editor. The AAS soon changed its name to the American Plant Life Society (APLS), incorporated as a non-profit corporation in California, and the name of its annual publication became *Herbertia/Plant Life*. Dr. Traub continued as the Editor of *Herbertia* until his death in 1983. The non-profit incorporation charter was updated in 1990, and the APLS changed its name to the International Bulb Society (IBS) which was more indicative of its membership and specialty interest.

In 1970, Dr. Traub befriended a young plantsman named Herbert Kelly Jr. Then age 26 years, Kelly had recently opened a commercial and mail order nursery named Kelly's Plant World. Dr. Traub took young Kelly under his tutelage. Kelly eventually began to assist Dr. Traub in compiling a detailed index of *Herbertia*, and Kelly became involved in the activities of APLS, including chairing the *Crinum* Section. Kelly also began to publish articles in *Herbertia*. Dr. Traub imparted much of his philosophy on plants and horticulture to Kelly, including the operations of APLS and the *modus operandi* of its annual publication *Herbertia*. It was Traub's wish that Kelly would someday be awarded the Herbert Medal (the Society's yearly merit award) if Kelly could successfully develop a yellow *Crinum* hybrid. Traub's death was a devastating blow to Kelly, and Kelly resolved that he would do his utmost to ensure the continued success of APLS in honor of his friendship with Traub.

As a child, Kelly was introduced to trees and plants by his grandparents, who operated a commercial vegetable garden and orchard. In school he became fascinated with Luther Burbank after reading a biography about him, and Kelly began to dream about the possibility of becoming a plantsman. This was not a mere coincidence since an apprentice of Burbank, William H. Henderson, operated Henderson's Experimental Gardens near Kelly's home. Kelly frequented Henderson's Garden as a young boy, where Henderson, and Henderson's chief propagator Bill Wilson, both were keen to teach him the fine points of horticulture techniques. Soon young Kelly was developing his own hybrids and plant selections, and he began to amass a large personal plant collection. When Kelly opened his nursery, the bulk of his stock was the plants he had developed himself, and during the course of his life, he introduced >160 new plant and tree selections to his customers.

In the meantime, the APLS had transformed into the IBS since Traub's death, and a number of different presidents, editors, and board members had rotated in and out of the Society's Board of Directors. In 1999, IBS President Robert Turley invited Kelly to become a member of the Board of Directors, where he became Director of the Awards and Recognition Committee (a position he has continued to hold to the present day). Kelly also was soon appointed to the Conservation Committee, and he chaired the IBS Symposium at the Huntington Library and Botanical Garden in 2002. In 2003, Kelly assumed the position of Director of the Seed and Bulb

Exchange, immediately transforming it into a profitable venture (a position he has continued to hold to the present day). From 2003 through 2008, Kelly accessioned an average of >200 different seed/bulb offerings per year to the IBS Membership through the Society's E-mail Forum, raising over \$90,000. in donations. Operation of the Seed and Bulb Exchange was very time consuming, and to undertake such a commitment was especially remarkable since all Board Members were unpaid volunteers.

Then in 2004, the Board of Directors unanimously voted to award the 2005 Herbert Medal to Kelly. Yes, Kelly had developed a yellow *Crinum* hybrid, the only one known in existence, but there were many other factors contributing to this meritorious award. The write-up of his award, biography, and resume was published in *Herbertia* Volume 59:20-29, 2005, and this was followed by one of his major publications: *The Elusive Hymenocallis Eucharidifolia* Baker (Amaryllidaceae) in the same *Herbertia* Volume 59:37-71, 2005.

In spite of Kelly's success and contributions, a period of dissension overtook the IBS Board and the Society's publications fell into serious arrears (*Herbertia* was 4 years delinquent). Things began to look bleak for the survival of IBS as the membership began to decline, and the acting President suggested that the Society should disband. Kelly would have no part of such an action and argued vigorously that the Society needed a new direction; i.e., return to the philosophy of Dr. Traub. A Board Meeting was convened, and Kelly was appointed Acting President of IBS in January 2008.

In the ensuing 18 months, Kelly brought new life into IBS. His energy seemed boundless as he devoted extraordinary amounts of time to changing the prevailing atmosphere. He also introduced a personal touch by introducing new members to the E-mail Forum and by calling new IBS members in the USA on his cell phone to welcome them to IBS. *Herbertia* was brought current with 4 volumes published, and articles for future publication began flowing in to the Editor. The IBS Website was redesigned. New records for e-mail postings were set on the IBS E-mail forum. It became a different ballgame.

Dr. Traub would be proud of his protégé.

***Note:** Biographical summary submitted on August 12, 2009 to a special subcommittee of the IBS Awards and Recognition Committee for consideration of the 2010 Hamilton P. Traub Award.

**2010 TRAUB AWARD
ROBERT THOMPSON**



Fig. 1. Robert Thompson standing in northwest Thailand near the Myanmar (Burma) border.

**ROBERT THOMPSON
AUTOBIOGRAPHY**

I was born in 1952 in Whittier, California, where I still reside. While attending Whittier High School, I began a serious interest in plants, growing bromeliads and amaryllids. I then began working for the Union Pacific Railroad in 1971 where I continue to work until today, now 38 years later.

During that span I have belonged to the California Rare Fruit Growers, Heliconia Society, International Aroid Society, Bromeliad Society International, Southern California Ti Leaf Society as well as the International Bulb Society. I am still President of the North Orange County Bromeliad Society.

Due to lack of space, I have not continued with rare fruit but I continue to be active in all the other societies.

Travel (mostly plant related) is my passion. I have been fortunate enough to have gone to the rain forest in the Peruvian Amazon as well as both Sarawak and Sabah in Borneo, French Polynesia, Costa Rica and Panama, Indonesia, Malaysia, Laos, Vietnam, Cambodia, and I am a frequent visitor to Thailand. My last trip to Cambodia (Kampuchea) saw just how far *Crinum xanthophyllum* has come as a landscape plant, covering two separate areas in the royal palace. It was also amazing to see so many variegated bulbs in Southeast Asia.

My wildest trip was from the North Thailand border through Myanmar (Burma) to the Chinese border. To me it was a most depressing sight to see most of the old forest turned into rice fields. It was strange to go through so many checkpoints and to be exposed to so many regional languages and different currencies. In the last district we had to greet people in Chinese and to use the Yuan as currency, even though we were still in Myanmar. There was no governing body but that of a warlord general, who had a palatial home by which one had to drive. But we did find 4 new flowering gingers that are now growing on my friend's farm in Chaing Mai, Thailand. My friend later returned to the areas where we had collected the gingers only to find the locations had been transformed into rice fields.

Crinumums are a particular interest now as are adeniums. Many of my crinumums were started from the IBS seed exchange. Growing ti leafs (*Cordyline*) from seed is a new rewarding hobby of mine.

It has been my pleasure to help volunteer during times when Herb Kelly Jr. and the Society needed me.

I am most appreciative of this award.

DESERT BULBS OF ISRAEL

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INTRODUCTION

The deserts of Israel cover more than half of the country; they stretch from the Judean Desert and the Dead Sea area south to the vast Negev Desert and the Eilat Mountains. These arid lands are divided into:

Semi-desert: 70-200 mm average annual rainfall, typical to the northern and higher parts of the region. Vegetation is diffuse - *Artemisia sieberi*, *Noaea mucronata* and other chenopod shrublets are dominating rocky slopes as well as washes and plains.

Extreme desert: 0-70 mm average rainfall, typical to the southern and lower parts of the region. Vegetation is contractile - woody plants such as *Acacia*, *Ziziphus* and tamarisk trees, but also shrubs and shrublets, are restricted to the washes. Slopes are naked and in extreme situations the washes are empty as well.

There are two main climatic features in the desert when compared to the Mediterranean region: decrease in average annual rainfall and increase in rain storm randomness (Sharon and Kutiel, 1986). It is very hard to predict when the next rain will come. Some years are rainier than the average but many others are drier. A pattern of several completely or almost completely dry years and then a rainier year or two is typical. Desert plants have to survive these unpredictable environments and many bulbs do so by surviving underground, almost dormant in dry years.

Geophytes are quite common in the semi-desert and comprise about 11% of the local flora (Fragman et al., 1999). The geophytic feature seems to be a great adaptation to the semi-desert conditions. In dry years many of them are dormant, in years with low rainfall many will sprout but will not bloom, and in the rainy years a whole variety of bulbous plants as well as annuals and other plants will bloom. In these latter years most seeds are produced and dispersed. The most prominent bulb-blooming peak in the desert is during February-March, a few species bloom before that in autumn to winter and a few later in April-May.

The extreme desert is very difficult for geophytes, as well as for other plants. In the long dry years many bulbs dwindle and often will dry out completely after several years; this is why very few bulbous species are found here.

CONSERVATION AND DISTURBANCE

Desert bulbs occur in diverse habitats. They are found in rocky slopes where they are more protected, but occur also on loessial plains, sandy patches and stony places.

The Israeli desert is blessed with several large nature reserves. The Ramon Reserve is the most famous one, covering the highest peaks of the regions reaching just a little more than 1000 m and also including the impressive Ramon Crater. The northern Ramon Crater cliff borders the semi-desert of the Negev Highlands and the extreme desert typical for the southern Negev Desert. Many other reserves cover the whole arid parts of the country; some large ones such as the Eilat Mountain Reserve in the far south end of the country and others along the Judean desert and the Dead Sea area.

The northern Negev and Judean Deserts suffer mainly from overgrazing, forestry and urban expansions. The rest of the Negev suffers from over grazing and military activities. Sandy areas suffer especially from sand mining and agriculture expansions. Several plant surveys were conducted in the past, though it is very difficult to evaluate plant richness in the desert, since blooming is very short and only occurs when there has been sufficient rainfall.

It is important to note that most of the bulbs in Israel are protected by law; this means that one is not allowed to collect or harm them in any way, anywhere. In nature reserves all plants are protected.

BULB SPECIAL ADAPCTIONS TO THE DESERT

During research supervised by Prof. Avi Shmida and Prof. Jaime Kigel of the Hebrew University of Jerusalem, we found that many desert bulbs produce dry tunics that protect them from water loss and even predation. The same tunics are produced in the Mediterranean region, but they rot during the longer wet winter. Most bulbs will not bloom in dry years and will save energy for better years, but some (*Allium decaisnei*, *Tulipa systola* and more) will continue to produce bulblets underground even in these

dry years. This vegetative reproduction was proved to be a cheap way for reproduction in dry years.

Most desert bulbs suffer from predation by porcupines, mole-rats, and even gazelles and other animals. Many bulbs are poisonous, and many will flourish in naturally protected habitats, such as rock crevices, deep sands, compact loess and other soils.

RECOMMENDED SITES

There are several recommended areas for bulb-flower watching. Regular excursions are conducted monthly by the Jerusalem Botanical Gardens as well as by other societies. It is important to have a good update on rainfall, for in dry years almost no flowers bloom, but rain storms occur almost any year somewhere in the desert. The latter will cause impressing blooming that will be much localized.

- Pura Reserve on the Tel-Aviv – Beer-Sheva Highway. Main attractions: carpets of *Anemone coronaria* and later *Ranunculus asiaticus*, *Gagea commutata*, *Urginea undulata* as well as many other perennials and annuals. Best time to visit – March.
- Goral Hills north of Beer-Sheva. Main attractions: *Iris atrofusca*, *Tulipa agenensis*, *Allium erdelii*, *Leontice leontopetalum*, *Gladiolus italicus* and *Ranunculus asiaticus*. Best time to visit – mid to late March.
- Tel Krayot near the town of Arad. Main attractions: *Fritillaria persica*, *Leontice leontopetalum*, *Allium erdelii*, *Allium aschersonianum*, *Gladiolus atroviolaceus*. Best time to visit – early March.
- Yerucham Iris Reserve north of the town of Yerucham. Main attractions: *Iris petrana*, *Ixiolirion tataricum*, *Moraea sisyrinchium*, *Asphodelus aestivus*, *Tulipa systola*, *Biarum angustatum*. Best time to visit – mid to late March.
- Shunra Sands, Km 132-135 on the road to Nizzana. Main attractions: *Iris mariae*, *Eminium spiculatum*, *Gagea dayana*, *Leopoldia eburnea* and carpets of unique desert annuals. Best time to visit – March (depending on rains).
- Lotz Cisterns near the western parts of the Ramon Crater. Main attractions: *Iris regis-uzziae*, *Tulipa biflora*, *Leontice leontopetalum*, *Ferula biverticillata*, *Crocus cencellatus* (desert form), *Colchicum tunicatum* and *Urginea maritima*. Best time to visit – early October and early March.

THE DESERT BULBS OF ISRAEL

Almost all desert geophytes of Israel are detailed here in text, mostly in pictures as well. All pictures were taken in nature during the last 25 years. The basic knowledge on the region's bulbs was based on *Flora palaestina* (Feinbrun, 1986). Additional information was gathered in the field during private botanical excursions and other field trips organized by "Rotem" - Israel Plant Information Centre, the Society for the Protection of Nature in Israel, Israel Nature and Parks Authority and the Jerusalem Botanical Gardens.

Plant families are listed alphabetically in the text. In the pictorial section, images are arranged alphabetically by genus, and within each genus the associated species are displayed alphabetically.

Alliaceae

Allium artemisiatorum is one of the commonest desert bulbs, growing mainly in rocky slopes. It is also one of the few bulbs that penetrate the extreme desert. Its compact whitish flowering head opens in late spring after leaves are dry and all other flowers are gone. The purplish anthers are exerted, and the first flowers to open are the upper ones.

Allium sinaiticum is a similar shorter plant with a dense whiter flowering head and a bended scape. Often part of the plant is covered by sand. It is a rare and endangered species occurring only in sandy places within the extreme desert. In spring 2010, which was rainy in the southern Negev, we found it in the Arava Valley sands as well as in sand pockets in the southern Negev; a new population was found in the Ramon Crater by Dr. Oz Golan.

Allium aschersonianum is a beautiful species occurring sparsely in the semi-desert as well as rainier areas in the transition zone between the desert and Mediterranean regions. In the semi-desert it grows in two different habitats: sandy places and limy-rocky slopes. Like many of its relatives, leaves are not garlic-scented and are connected to an underground stem and vegetative reproduction is very low. The species is cultivated and commercially available in Israel (Avishai et al., 2005)

Allium rothii is a much shorter, related species; it is confined to the Negev Highlands (locally frequent), South Jordan and other arid mountains in

the Middle East. Perianth is greenish, but filaments and ovary are shiny black-purple, giving the flowering head a very dark and special appearance. In the northern Negev and transition zone there is a related white flowered species, treated in Flora Palaestina as *Allium orientale* (Feinbrun, 1986). Recent molecular data (Fritsch et al., 2010) shows that it is definitely not the *Allium orientale* that was described from southern Turkey, and it might be a new species.

Allium decaisnei is a common shy garlic, often found in the northern Negev Desert, mainly in loessial hills and plains, but rarely in rocky places. It is closely related to the Mediterranean *Allium stamineum*, differing in its straight scape, pale straw flowers and bulb that produces small bulblets (not splitting). *Allium decaisnei* has pendulant flowers; it blooms in April after most other desert spring flowers are gone.

Allium sindjarens is similar in flower season and general appearance; but it has stout and straight flower stalks and non-pendulant flowers with purple filaments and dark mid-veined perianth segments. It grows mainly in sand within the extreme desert. During spring 2010 we were lucky enough to see large populations of this species blooming in the Ramon Crater sands.

Allium desertorum is a shy bulb that occurs sporadically in stony slopes as well as in loessial to sandy plains. It has typical constricted white flowers that bloom in late March-April. It is probably much commoner than known; due to its small size it is overlooked.

Allium kolmannianum is a peculiar shy-garlic that blooms in May, long after everything else is gone. Spathe is united in its lower part, splitting into 2. Flowers are arranged in 2 rows, all directed-pending to one side, but after blooming they are erect again. The species was described in 1991 (Brullo et al., 1991) from bulbs collected in the Negev and grown in Sicily. This species was named after the late Dr. Fania Kolmann, a famous specialist of old world garlics, working at the Hebrew University of Jerusalem. The plant was unknown in nature until it was re-found in 2007 by Dr. Oz Golan north of the city of Beer-Sheva in the northern Negev. It is probably much more common than known; due to its small size and late blooming time it is overlooked.

Allium negevense is a Molium *Allium*, endemic to the Negev Desert Highlands, where it is quite common in stony slopes. It forms small vegetative clumps that bloom only in rainy years. It has rather short leaves and a 20–40 cm tall scape, ending with long creamy flowers.

Allium erdelii and *A. qasyunense* are very similar species, replacing *A. negevense* in the northern Negev and Jordan Valley. The first is a shorter plant with leaves that are hairy on both sides; the second has shorter flowers, but otherwise is almost identical to *A. negevense*.

Allium papillare is another similar species; it is a short, stouter plant with short creamy flowers. It is a rare and endangered species confined to the sands of the western Negev and Sinai Peninsula (Egypt).

Allium palaestinum is also a Molium *Allium* with milky-white flowers. It is very close to the Mediterranean *Allium neapolitanum* and included in it by Kolmann and Feinbrun (Feinbrun, 1986). Unlike *A. neapolitanum* that has triangular stems, *A. palaestinum* has rounded stems and is restricted to rocky habitats in the semi-desert and transitions zone.

Allium pallens is an interesting species growing in diverse habitats from the desert to the Mediterranean region. Flower stalks are equal and perianth segments are white with dark mid-veins. In the desert this plant is rather short; tall variants are known only from the Mediterranean region.

Allium truncatum is a tall plant occurring in disturbed habitats mainly in the semi-desert. It has compact purple flowering heads. The bulb produces many bulblets that are borne on stolons. This species is closely related to *A. ampeloprasum* that is commoner in the Mediterranean area.

Allium dictyoprasum is also a tall garlic; it blooms in late April–May. It has smaller green flowering heads and typical reticulated bulb tunics. It is a common in the central Negev Highlands, but absent from the rest of the region. In the northern parts of the country it occurs again in the Jordan Valley and lower Golan Heights.

Amaryllidaceae (see Fragman-Sapir, 2007)

Narcissu tazetta is primarily a common protected Mediterranean species. Disjunctive populations occur in the Negev Desert Highlands (400-700 m), which are geologically the continuation of the main Mediterranean mountain ridge of northern and central Israel. They are probably relicts from colder times. They survive in the cracks and surroundings of smooth rock outcrops that contribute substantial addition of run-off water to the plants.

Pancratium sickenbergeri is a desert vicariant of the famous Mediterranean *P. maritimum*. It is protected and rather frequent in the sandy desert, occurring in disjunctive populations throughout the Negev Desert. Sites and populations are detailed by Fragman-Sapir (2007). The most prominent feature of this species is the coiled (not twisted) leaves, definitely an adaptation to arid conditions (decreased water evaporation).

Sternbergia clusiana is a striking desert flower. Its huge hysteranthous flowers amaze nature lovers every year. The species occurs mainly along the Fertile Crescent of the Middle East from Israel and Jordan, through Lebanon and Syria to South Turkey, North Iraq and West Iran. In the deserts of Israel it grows in the Judean Desert, northern Negev Desert and central Negev Highlands. More details about this species are detailed by the author (Fragman-Sapir, 2007).

Apiaceae

Ferula biverticillata is a unique hysteranthous plant that blooms in late summer and in autumn. It has a huge underground tuber. The waxy stem is purplish, much branched, and bears loads of tiny yellow flowers. It is a tumble weed typical to loessial valleys of the central Negev Highlands, where it is locally common. The leaves occur in December; they are grey-green, 3-pinnate into tiny lobes.

Araceae

Biarum angustatum is a hysteranthous tuberous plant that blooms in October. It is found in the lower Negev Highlands. Recent observations show that at least some of the plants are not typical *B. angustatum*, but have an inflated spathe tube and resemble *B. pyrami* that occurs from North Israel and Turkey. Inflorescence is dark brown to purple; like many

other aroids, it attracts flies that pollinate the flowers but are deceived since no food reward is offered. Leaves are lanced, occurring only after rains.

Biarum olivieri is the second desert *Biarum* in the region. It is a peculiar and an extremely rare and endangered species, known from only a handful of sites in Israel and Egypt. It grows in sandy habitats; it has narrow lanced leaves and a narrow inflorescence that is partly buried in sand.

Eminium spiculatum is a spring blooming aroid with heart-shaped leaves that have secondary spiral lobes. The spathe is fleshy, dark and wrinkled. The desert populations of this species belong to ssp. *negevense*; they occur in the sands of the western Negev and Sinai (Egypt), where they are frequent.

Asphodelaceae

Asphodelus aestivus is primarily a Mediterranean species that penetrates the semi-desert but is absent from the extreme desert. It is locally common in the northern Negev, dominating in overgrazed localities where one can see white carpets of this species. Its peak blooming takes place in wintertime (December-February). In the central Negev Highlands one can find also *Asphodeline lutea*, another relict, a typical Mediterranean species that has a non-divided yellow-flowered inflorescence.

Asteraceae

Scorzonera are tuberous perennials that produce typical leaf rosettes and ligulate flowering heads.

Scorzonera judaica is a shy stem-less, common plant of semi-deserts with small yellow inflorescences and very hairy leaves, it blooms in January-March.

Scorzonera pusilla has a distinct stem and narrow flowering heads; it is an extremely rare and an endangered species, found in 2010 in a new site in the Ramon Nature Reserve by Dr. Oz Golan.

Scorzonera papposa is common throughout the semi-desert and northwards to the Mediterranean region. It has a distinct stem and larger

violet inflorescences. A similar plant in the Negev Highlands is *Tragopogon collinum*; unlike *S. papposa* it has only one layer of inflorescence bracts.

Berberidaceae

Leontice leontopetalum is an extremely widespread species of arid Asia and southern Europe. In Israel it is common in loessial plains and valleys whether they are traditionally managed as agricultural fields (northern Negev), fallow field (northern Negev) or natural grassy places (central Negev Highlands).

Colchicaceae

Androcymbium palaestinum is a beautiful cormous plant. It occurs sporadically in the eastern deserts along the Rift Valley. Some populations are in the extreme desert, blooming very rarely and most are within semi-desert and the transition zone. The plant has a typical leaf rosette and a few dense flowers in it. Perianth segments are often striped, sometimes dotted, but rarely plain.

Colchicum ritchii is one of the lovely winter-blooming colchicums. The plant typically has three leaves and either white or pink flowers. The inner perianth segments have fringed appendages above a special nectarial tube. Large continuous populations occur in loessial plain of the northern Negev near the city of Beer-Sheva eastwards to the town of Arad and southwards to the town of Yerucham. South from there the species is disjunctive and rare. In the extreme desert in the far southern Negev there is a remote population in Se'ifim Plain - plants here bloom rarely and have much narrower leaves.

Colchicum tuviae is common in loessial soils of the northern Negev and Judean Desert. In the Negev Highlands it becomes rare. It is a unique endemic that has much fringed appendages, mainly on the inner perianth. Flowers are normally pure white, rarely pinkish. It blooms in late-November and December and is sub-synanthous. In the Ramon Reserve of the central Negev Highlands there is a smaller similar *Colchicum*, its identity is not clear yet and for the time being we treat it as a form of *C. antilibanoticum* that occurs much further north in Mt. Hermon at the border of Israel, Syria and Lebanon.

Colchicum tunicatum is a common species of the Negev Highlands; in the Judean Desert it is very rare. Corms are often dug and devoured by porcupines, which leave behind only the dark corm tunics. The shy pink flowers occur in September, while leaves develop much later in December. During its blooming time, it is almost the only flower around.

Geraniaceae

Erodium crassifolium is one of the commonest desert perennials. It has small root tubers, rather fleshy leaves that are deeply divided, and beautiful pink-violet flowers that have a dark central patch which differs in size between plants. After blooming, the feathered seeds are distributed and lodge in soil cracks as well as in other plants and obstacles. In the extreme desert one can find also the similar and rarer ***E. arborescens***; it has entire leaves and blooms only in rainy years every 5-10 years.

Hyacinthaceae

Bellevia desertorum is a short plant, growing in rocky-stony habitats. It is very common in the semi-desert and rare in the extreme desert. It is a local endemic, found in Israel, southern Jordan and Egypt (Sinai). Its fleshy leaves are somewhat coiled and fleshy, often pale dotted. The dots look like scars and their origin is not clear. The tubular flowers are white to pale blue and bloom in wintertime: December-February. Fruits are large, dispersed by wind.

Bellevia zoharyi is another local endemic; it is also a short species, but it has distinct ciliate, prostrate leaves that are broad at base. It is confined mainly to the Negev Highlands, but also occurs in the south Jordanian mountains. It blooms mainly in March.

Bellevia eigii is the third common *Bellevia* species, a larger-taller plant with straight or bended scapes; it is found in the loessial valleys and washes of the semi-desert.

Dipcadi erythraeum is a peculiar species with two narrow leaves and brown flowers. It is found only in sandy habitats. The sands absorb more water compared to the loess soils, and are considered a favored habitat in this sense. Large populations of *Dipcadi* are found in the western Negev

sands within the semi-desert. Smaller disjunctive populations can be found in the rest of the desert down to the Arava Valley sands in the very extreme desert in areas that receive an annual average precipitation of only 40-50 mm. These plants will bloom rarely; recently they were dormant for 7 long years and bloomed in spring 2010.

Hyacinthella nervosa grows in the arid Middle East, it can be found mainly in the north part of the region in the Samaria and Judean Deserts, where it is rare but locally occurring in large populations. Disjunctive populations are also found in southern Jordan. This is a shy, but charming bulb that has bluish flowers and two somewhat coiled leaves. It blooms in February together with *Gagea* and *Muscari*, before spring comes in March.

Leopoldia eburnea is a narrow endemic of the sands of the western Negev and Sinai (Egypt). This peculiar species has only one leaf and dense, ivory flowers (hence its name). The upper part of the inflorescence has black sterile flowers. Although it is not critically endangered, it suffers from sand-mining, forestation and crushing by goats.

Leopoldia longipes is an impressive semi-desert bulb that grows in the entire arid Middle East. Locally it is found in loessial plains and valleys (ssp. *longipes*) and rocky slopes (ssp. *negevensis*) which are endemic to southern Israel and Egypt-Sinai. Upper flowers are violet, becoming creamy as they open. Lower flower stalks are much longer than upper ones. Fruiting inflorescence is pyramidal-cylindrical and tumbling, thus dispersing its seeds.

Muscari commutatum complex *M. commutatum* is common in the transition zone between the desert and Mediterranean climatic regions in Israel. It is a variable species that evolved into two main species in the desert: 1) *Muscari filiforme*, a shy bulb with typical thread-like coiled leaves, known only from the north-eastern Negev. 2) *Muscari inconstictum*, a commoner plant that has open flowers. It is found in Judean and Samaria deserts, as well as in wetter areas of the transition zone. In Samaria there are local forms with longer-tubular flowers.

Ornithogalum narbonense ssp. *brachystachys* is a very common plant in semi-desert rocky habitats and throughout the eastern Mediterranean. It is primarily a Mediterranean plant that penetrates the desert in rock outcrops where run-off dramatically improves water availability. In the loessial plains and washes one can find *O. trichophyllum*, a common, very short bulb that has thread-like leaves. In the Negev Highlands there is a third species with coiled leaves; it was treated as *O. neurostegium* ssp. *neurostegium* in the Flora Palaestina (Feinbrun, 1986), but we suspect it is a different species; further research is needed in clarify that.

Scilla hanburyi is one of the commonest desert bulbs, occurring almost everywhere in rocky or stony places within the semi-desert. There is almost no vegetative reproduction which occurs only if the bulb is physically harmed. There are 1-5 scapes per plant, mostly occurring before leaves. Flowers are white and flower stalks elongate dramatically in fruit. The inflorescence tumbles a little, dispersing its black seeds. Leaves are twisted, forming a typical rosette. In the northern Negev and upper Judean Desert there are populations with shorter pedicels. This species occurs in the deserts of Israel, Egypt, Jordan and Syria. It is vicariant to the famous Mediterranean *S. autumnalis* that has normally violet flowers.

Urginea maritima is a common Mediterranean species. It penetrates the semi-desert as well as the extreme desert, mainly in rocky habitats. In September, impressive scapes pop-up from the dry soil and are in fantastic contrast to the dry surroundings. Fruit set is immediate and the seeds are distributed soon. Leaves will develop only in November onwards. Unlike this prominent species, *U. undulata* is a shy plant with camouflaged brown flowers; it has typical undulate leaves. It is frequent in the semi-desert in loessial and rocky habitats.

Iridaceae

Crocus cancellatus occurs in the central Negev Highlands above 700 m as a disjunctive population; blooming takes place usually in early October. Flowers have peculiar bent anthers, and research is needed in order to see if this is a new species or subspecies. In its blooming time it is the only flower around.

Oncocyclus irises. There are 3 species belonging to this section. ***Iris atrofusca*** occurs in the northern Negev Desert and in the Judean Desert. It is endemic to Israel and Jordan where it grows in shrublet plant communities in loessial fields whether they are cultivated (barley is grown by Bedouin for fodder) or fallow. Its huge scented blackish flowers are striking against the arid landscape. This species suffers from forestation, overgrazing and modern agriculture. ***Iris petrana*** has narrower leaves and a bit smaller flowers. Its floral colours are also dark, but more wine coloured. It grows in the sandy areas in the vicinity of the towns of Yerucham and Dimona. There are many colour variations within populations of this species including yellow, whitish and reddish flowers. The species is protected in the Yerucham Iris Reserve north of the town of Yerucham. The last *Oncocyclus* iris is ***Iris mariae***, a delicate flower of the western Negev sands. It has violet flowers, a black beard and deeply falcate leaves; this species suffers mainly from grazing and military activities.

Iris regis-uzziae is the only Juno iris in the area. It is found in the Central Negev Highlands as well as in the south Jordanian mountains (although these disjunctive populations differ morphologically). Its distichous, white margined leaves and whitish flowers are prominent. In the higher elevations of the Negev there are bluish-violet flowers. After drying the elongated capsule opens and reveals dark, rounded seeds. The whole plant tumbles and disperses them.

Moraea sisyrinchium is one of the commonest small semi-desert bulbs, occurring in rocky, stony and sandy places. It is primarily a Mediterranean species penetrating the deserts. Its two narrow leaves are typical and often the flowers are amazing dark violet-purple, although light ones are also common.

Moraea monophylla is a rare and endangered plant of the western Negev sands. It has smaller pale violet, flattened flowers and often only one leaf. There is a need for a new revision of the Mediterranean moraeas, especially peripheral species like this one.

Ixioliriaceae

Ixiolirion tataricum is a protected species, occurring throughout the semi-desert. Its small corm produces grass-like foliage that is inconspicuous in dry years when plants do not bloom. In rainier years there are amazing violet flowers that open in April after most other spring annuals and bulbs are gone.

Liliaceae

Fritillaria persica, a protected Middle Eastern species, is rare in the desert. It occurs in a large population only in Tel Krayot, not far from the town of Arad. Here it grows in a loessial plain together with many other bulbs and perennials. Flower colour varies from purple to green and even yellowish and whitish. Blooming takes place in late February to early March, when the pending flowers fruit into upright ribbed capsules.

Gagea species. ***Gagea reticulata*** is the commonest of this genus. It has distinct reticulate bulb tunics that form a sock around the lower stem and pointed perianth segments. It is a desert plant that grows in sandy and loessial-stony places.

Gagea chlorantha is less common, although especially common in the higher elevations of the Negev Highlands. It has rounded perianth segments tips.

Gagea dayana var. ***conjungens*** is confined to sands; it is a rare plant that has typical thick fibers that envelope the bulb.

Gagea fibrosa is common mainly in the Judean Desert; it has a net of irregular roots that cover the bulb.

Gagea libanotica (= ***Lloydia robroviridis***) has whitish flowers; it is primarily a plant of much higher elevations of the Lebanon and Anti-Lebanon mountains (Fragman-Sapir, 2009). Disjunctive populations were found in south Jordan and in the central Negev Highlands. In the Negev it is a rare and endangered plant.

Tulipa biflora (= ***T. polychroma***) is also confined to the central Negev Highlands, where it is locally common, blooming in early March. Its white flowers have a yellow patch in the centre and are often dark-purple marked on the outside. Most plants will have a forked stem and 2 flowers (hence its name), some will have one flower and some three.

Tulipa systola has striking red flowers. In Israel it is not a good species; there are many plants within populations that look just like the Mediterranean ***T. agenensis***. There is a need for new research on the red tulips of Israel and its surroundings; it is rather clear that they form one species with local varieties.

Ophioglossaceae

Ophioglossum polyphyllum. It is not clear if this plant falls into the description of a real geophyte. At any rate, it has thick root cluster that sprouts in rainy years producing leaves and sporophytes. It is an extremely rare and endangered species of the extreme desert, occurring in 2 sites along the Arava Valley. In 2010 it sprouted after 7 years of drought.

Polygonaceae

Rheum palaestinum. A striking plant, endemic to desert highlands of southern Israel, southern Jordan and northern Saudi-Arabia. It has a thick tuber that produces normally two flat leaves that collect large amounts of water (Lev-Yadun, 2009). Only in rainy years will it bloom. The inflorescence looks like a small bonsai tree covered with red flowers and later by hanging rounded fruits. It is a rare and endangered species, a relict from colder times, closely related to ***R. ribes***. Its blooming sites are places of pilgrimage to nature lovers in rainy years.

Ranunculaceae

Anemone coronaria is a primarily Mediterranean plant that survives in semi-desert in grazed loessial plains as well as in washes in the desert highlands. This protected species blooms in January-February and is later replaced by another protected, red flowered, Mediterranean plant - ***Ranunculus asiaticus***.

Delphinium ithaburense is a rare perennial with a fleshy root cluster, similar to the one in *Ranunculus asiaticus*. It grows mainly in the arid Mediterranean area and in the transition zone. In the central Negev Highlands it is rare, occurring in loessial soils within rock outcrops, like many other bulbs.

CONCLUSIONS

The rich geophytic flora of the deserts of Israel is important in this arid environment. Plants from different families evolved to survive these harsh conditions. The research on these species has just begun. Additional research will provide knowledge on physiological and morphological adaptations that will be of interests to ecologists, botanists and horticulturists. Several of the showy species are of great potential to water-wise agriculture that becomes so important in the past years when precipitation decreases and water prices soar. Furthermore, ecological research on vegetative reproduction in these bulbs will no doubt reveal important understanding of this exciting character, especially when compared to wetter Mediterranean regions.

It is my hope that this article will tempt the readers to come and visit our vast deserts and the Jerusalem Botanical Gardens where some of these species and many others grow.

All photographs by the author except where indicated

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Fig. 1. *Allium artemisiatorum*, central Negev Highlands, Maale Arod, 10 May 2004.



Fig. 2. *Allium aschersonianum*, Judean Desert, Wadi Kelt, 7 March 2005.



Fig. 3. *Allium decaisnei*, north Negev, Beer-Sheva, 31 May 2007.



Fig. 4. *Allium desertorum*, west Negev, road to Nizzana, 10 April 2007.



Fig. 5. *Allium erdelii*, north Negev, Goral Hills, 6 March 2010.



Fig. 6. *Allium kollmannianum*, north Negev, Nahal Ashan near Beer-Sheva, 31 May 2007.



Fig. 7. *Allium negevense*, South Israel, Rachme Ridge, 15 March 2007.



Fig. 8. *Allium palaestinum*, Samaria Desert, Sartaba, 16 February 2008.



Fig. 9. *Allium papillare*, west Negev, 1 March 2003.



Fig. 10. *Allium qasyunense*, south Golan Heights, above Hamat Gader, 13 March 2009.



Fig. 11. *Allium rothii*, central Negev Highlands, Nahal Nizzana, 14 April 2004.



Fig. 12. *Allium sidjarensis*, Ramon Crater, Wadi Ramon, 25 April 2010.



Fig. 13. *Allium sinaiticum*, Km 32 on the Arava Highway, 8 April 1987.



Fig. 14. *Allium truncatum*, Jordan Valley, Jiftlik, 8 May 1992.



Fig. 15. *Androcymbium palaestinum* and *Ornithogalum trichophyllum*, east Negev, Nahal Ma'ale, 2 February 2005.



Fig. 16. *Asphodeline lutea*, central Negev Highlands, below Mizpe Arod, 16 March 2007.



Fig. 17. *Bellevalia desertorum*, central Negev Highlands, Nahal Nizzana, 5 February 1994.



Fig. 18. *Bellevalia eigii*, Negev Highlands, Nahal Haro'a near Sde Noker, 17 March 2007.

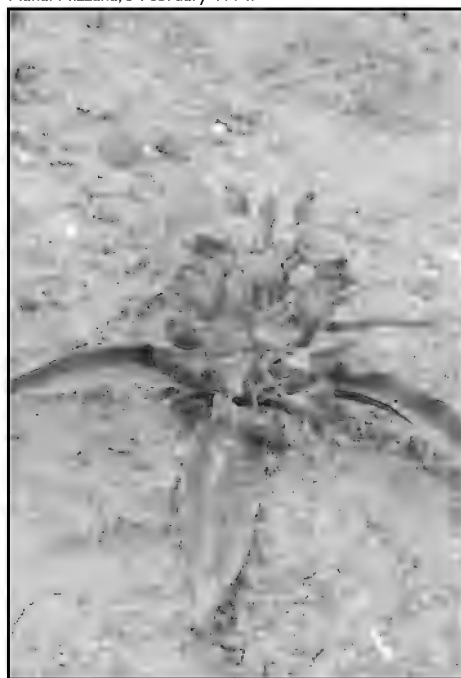


Fig. 19. *Bellevalia zoharyi*, central Negev Highlands, Mizpe Arod, 7 April 2007.



Fig. 20. *Biarum* aff. *pyrami*, eastern Negev Desert, Yerucham Iris Reserve, 20 November 1994. Photograph by Y. Marta.



Fig. 21. *Biarum olivieri*, west Negev, Mash'abim Sands, 24 November 2009. Photograph by Simon S. Cohen.



Fig. 22. *Colchicum* aff. *antilbanoticum*, central Negev Highlands, near Lotz Cisterns, 17 December 2009.

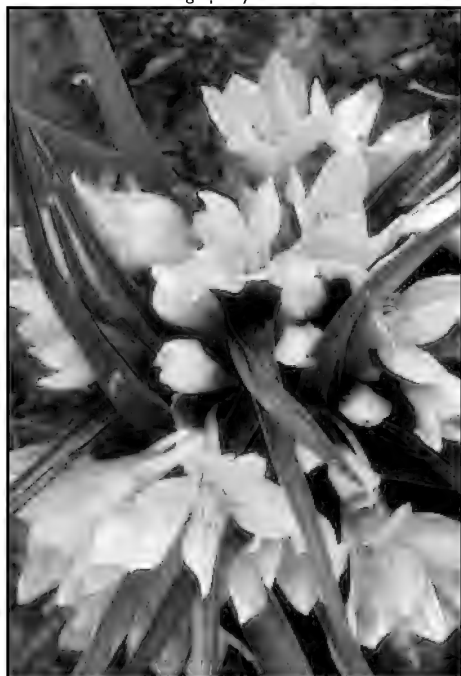


Fig. 23. *Colchicum ritchii*, north Negev, Beer-Sheva, 10 January 1987.



Fig. 24. *Colchicum tunicatum*, Negev Highlands, Sde Boker, 24 September 1993.



Fig. 25. *Colchicum tuviae*, Negev Highlands, Sde Boker, 2 December 1989.

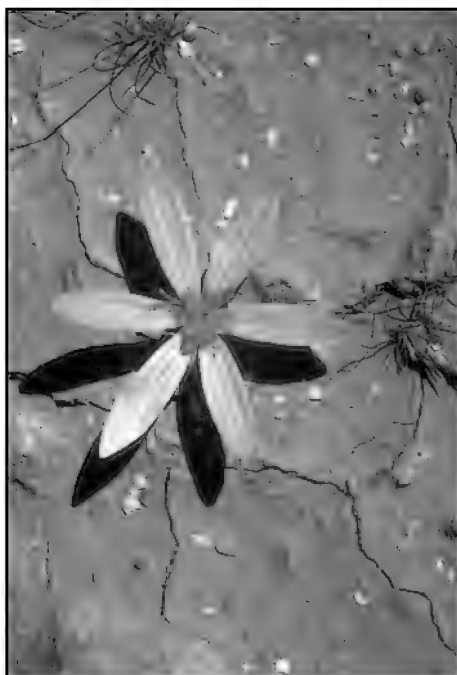


Fig. 26. *Crocus cancellatus*, central Negev Desert Highlands, Lotz Cisterns, October 1992.

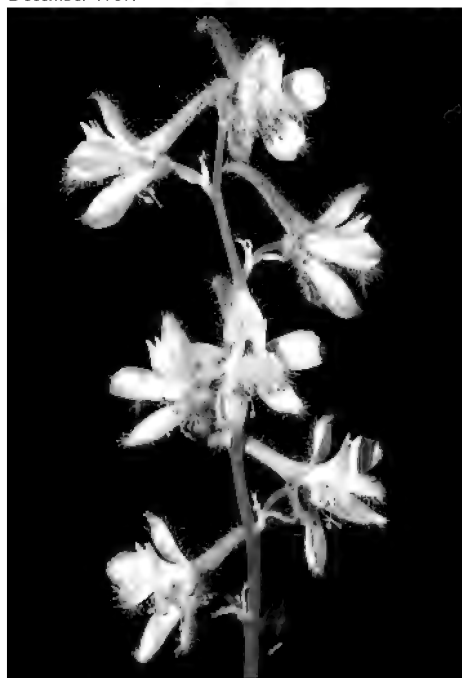


Fig. 27. *Delphinium ithaburense*, west of Jerusalem, 13 May 2005.



Fig. 28. *Dipcadi erythraeum*, west Negev, Nahal Secher sands, 21 February 2010.



Fig. 29. *Eminium spiculatum* ssp. *negevense*, west Negev, Shunra Sands, 17 March 2008.



Fig. 31. *Erodium crassifolium*, Negev Highlands, Mt Retamim, 600 m, 7 April 2007.



Fig. 30. *Erodium arborescens*, south Negev, 2007. Photograph by Mori Chen.



Fig. 32. *Fritillaria persica*, north Negev, Tel Krayot, 19 March 2008.



Fig. 33. *Gagea chlotantha*, Negev Highlands, Halukim Ridge, 5 February 1994.

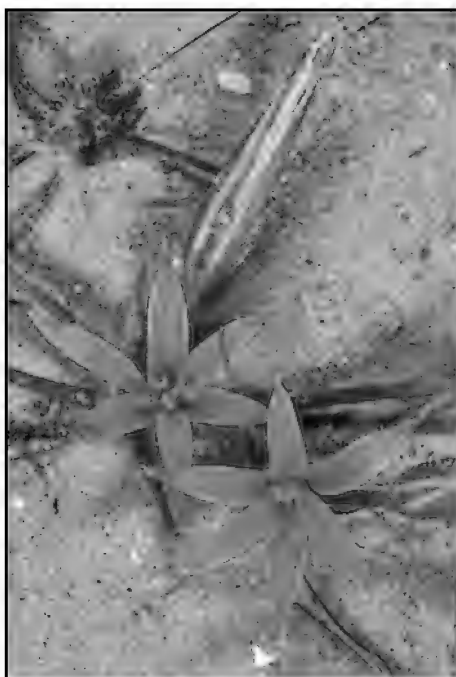


Fig. 34. *Gagea dayana* var. *conjungens*, west Negev sands, 29 February 2008.



Fig. 35. *Gagea libanotica*, Mt Hermon, 1750 m, 15 April 2010.



Fig. 36. *Hyacinthella nervosa*, Samaria Desert, Sartaba, 17 February 2008.



Fig. 37. *Iris atrofusca*, north Negev, Goral Hills, 17 March 2007.



Fig. 40. *Iris petrana*, east Negev Yeucham Iris Reserve, 8 March 2005.



Fig. 42. *Iris regis-uzziae*, central Negev Highlands, Lotz Cisterns, 3 March 2007.



Fig. 43. *Iris regis-uzziae* in fruit, central Negev Highlands, Ramon Reserve, 25 April 2010.



Fig. 38. *Iris atrofusca*, north Negev, Goral Hills, 12 March 2007.



Fig. 41. *Iris petrana*, east Negev Yeucham Iris Reserve, 21 March 2008.



Fig. 39. *Iris mariae*, west Negev, Shunra sands, 21 March 2008.



Fig. 44. *Ixiolirion tataricum*, central Negev Highlands, Mt Retamim, 600 m, 7 April 2007.



Fig. 48. *Moraea monophylla*, west Negev sands, Nahal Secher, 8 March 2005.



Fig. 46. *Leopoldia eburnea*, west Negev, Gvulot, 16 March 1991.



Fig. 45. *Leontice leontopetalum*, central Negev Highlands, Ramon Reserve, 16 March 2007.



Fig. 47. *Leopoldia longipes*, central Negev Highlands, near Mizpe Arod, 16 March 2007.



Fig. 49. *Muscari filiforme*, northeast Negev, Machtesh Gadol, 2 February 2005.



Fig. 50. *Muscari incontractum*, Samaria Desert, Sartaba, 17 February 2008.

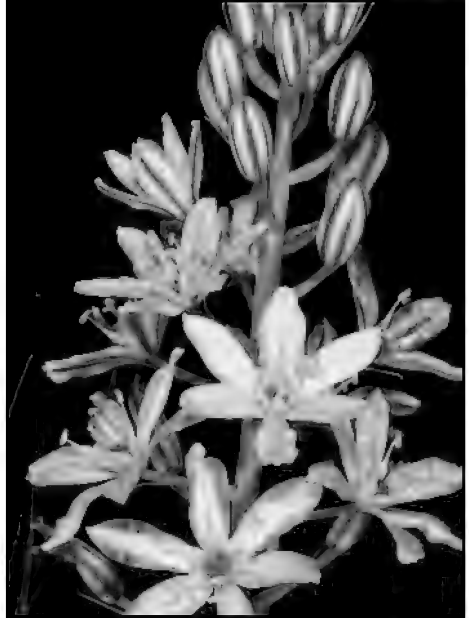


Fig. 52. *Ornithogalum narbonense*, central Negev Highlands, Mt Retamim, 600 m, 7 April 2007.



Fig. 51. *Ophioglossum polyphyllum*, south Arava valley, Samar, 6 February 1993.



Fig. 53. *Ornithogalum neurostegium*, central Negev Highlands, Lotz Cisterns, 12 April 1991.

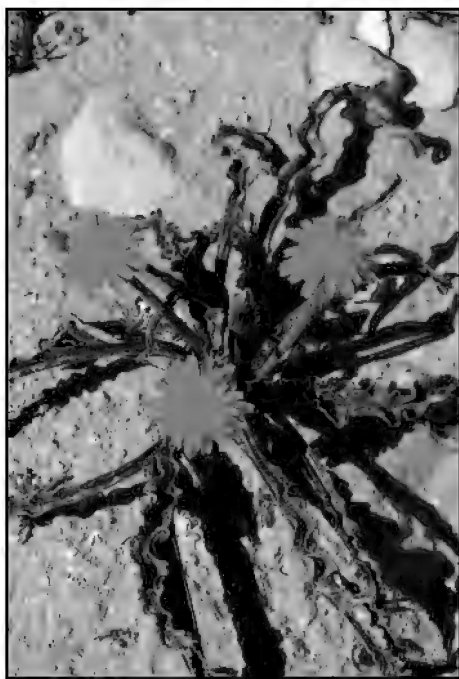


Fig. 58. *Scorzonera judaica*, central Negev Highlands, Lotz Cisterns, 3 March 2007.



Fig. 59. *Scorzonera pusilla*, South Israel, central Negev Highlands, west Haruchot Plain, 17 March 2010. Photograph by Oz Golan.



Fig. 60. *Tulipa biflora*, central Negev Highlands, Lotz Cisterns, 3 March 2007.



Fig. 54. *Ranunculus asiaticus*, Judean Desert, Wadi Kelt, 7 March 2003.



Fig. 57. *Scilla hanburyi* l., Negev Highlands, Halukim Ridge, 21 October 1994.



Fig. 55. *Rheum palaestinum*, central Negev Highlands, below Mizpe Arod, 16 March 2007.



Fig. 56. *Rheum palaestinum*, central Negev Highlands, below Mizpe Arod, 16 March 2007.



Fig. 61. *Tulipa systola*, Negev Highlands, Halukim Ridge, 2 March 2007.



Fig. 63. *Urginea maritima*, central Negev Highlands, Rosh Elot, 5 October 1992.



Fig. 64. *Urginea undulata*, Jerusalem Botanical Gardens, 1 September 2009.



Fig. 62. *Tulipa systola*, Negev Highlands, Boker Ridge, 21 February 2010.

THE REDISCOVERY OF *HAEMANTHUS AVASMONTANUS* (AMARYLLIDACEAE) IN NAMIBIA

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INTRODUCTION

Haemanthus avasmontanus was originally found and described as a new species by Kurt Dinter in 1923, from plants collected on the Farm Tigerfontein in the Auasberge to the east of Windhoek. There were also three syntypes. Two were collected by Dinter, one in the Auasberge and another at Dobra (Brakwater) just north of Windhoek in the Otjihaveraberg. The other syntype was collected by Rusch in the Khomas Hochland Mountains west of Windhoek. The bulbs were recorded in the type description as growing on steep south-facing micaceous-schist ledges, and the flowering time was said to be February. This was the month in which the type material was collected in flower. These descriptions of the plant and the original collection-details were published by Dinter (1923) under the name *Haemanthus avasmontanus* and recapitulated by Snijman (1984).

The species was subsequently lost from the formal botanical record for 83 years. This was astonishing as the area was traversed by a number of sharp-eyed botanical explorers and was in close proximity to Windhoek which was the Namibian centre of botanical learning. Inge Pehlemann, a knowledgeable plant enthusiast from Windhoek, found the *Haemanthus* at Dobra once more in the 1970s but did not publish her finding and a specimen was not lodged in a herbarium. Research was not carried out again at Dobra as the locality was considered unsafe to botanise in pre-independence Namibia. The place where Inge Pehlemann found the *Haemanthus* at Dorba had, in recent years, disappeared under a housing development. However, her find indicated that further searches in the Otjihaveraberg at an altitude of about 2000 metres were likely to yield positive results.

Haemanthus avasmontanus was one of several little known plants I had hoped to feature in a book on habitat changes and accordingly efforts

were made to find and study the plants. Species such as *H. avasmontanus*, only known from the type collections, often required patience and skills to relocate and also favourable climatic conditions. This was particularly so in much of Namibia, a region subject to frequent and prolonged droughts.

The rainy seasons of 2009 and 2010 proved to be years of good rainfall, and it was decided to make some preliminary attempts to find the species. The first field excursions took place in the first half of May 2009, and on these occasions I was accompanied by Inge Pehlemann and by Dawie Human, a botanical explorer from the Free State. It was thought that this would be a time to find the plants with their leaves starting to die back.

A large mountain to the south east of Windhoek near Aris was searched for suitable habitat and plants. There were no gorges with seasonal streams on this mountain, and it also lacked the proliferation of partially shaded south-facing ledges which were, it transpired later, a prerequisite for the plants to flourish. It was decided to spend the remainder of the time available searching likely looking places on the Otjihaveraberg, a long range of mountains that ran in a north south direction from near Windhoek to almost as far as Okahandja. This was a distance of about 70 kilometres.

The locality on the mountain chosen for the search consisted of rugged countryside with recessed gorges fringed with cliffs and steep grassy slopes. After a number of hours spent searching likely habitat with no results, attention was focused on a gorge, hidden from view from the base of the mountain. Several tan-brown leaves were noted in the final stages of dying back. These leaves were protruding from soil pockets on broad ledges of small cliffs, from fissures in the cliffs themselves and on steep slopes. It was clear that these leaves must have been those of the *Haemanthus* but further research needed to be conducted during the rainy season. Data was collected on the plants in their dormant state as well as their distribution across the cliffs and mountain slopes.

It was hoped that the 2009-2010 rainy season would be another good one and fortunately this was what transpired. Good rains fell repeatedly in the Windhoek area as from the second half of December, and a field trip was planned for early February. The timing of the visit on 6 February fortuitously turned out to be ideally chosen. The plants were in prime condition in full leaf and easy to study.

The account which follows focuses on the autecology of the plants in full growth in early February and on entering dormancy in May. The

photographs which accompany the paper are important for their role in elucidating themes discussed in the text.

THE PLANTS IN THE LATE AUTUMN, MAY 2009

The locality in the Otjihaveraberg was first visited on 16 May 2009. An extensive search was conducted in likely looking habitat between about 1600 and 1700 metres. The mountains were very convoluted with steeply incised gorges, the largest of which had streams that flowed temporarily after good rainfall. In the biggest and longest gorge inspected, some tan coloured leaves were noticed protruding from the soil on cliff ledges and in rock crevices. Most of the leaves had died back fully but some were still green close to the top of the bulb neck.

These bulbs formed part of a widely scattered colony of *H. avasmontanus*. The impression gained at the time was that the plants were rather sparse, but even just prior to full dormancy a number of pertinent observations could be made. All the different niches where the bulbs were found faced south and they grew in places which retained moisture the longest after rainfall. It was clear that groups of bulbs consisted of plants of different sizes judging from the length of withered leaves. These ranged in length mostly from 11 to 17 cm.

Some of the bulbs were growing laterally-compressed into cracks of almost pure rock in places well irrigated from above even after minimal rainfall. This initial field visit prompted a number of questions which could not be answered until a good rainy season when the plants could be inspected and assessed in active growth. As luck had it very good rains fell in the Windhoek area in December 2009 and January 2010. Plans were made for fieldwork as well as for a photographer(s) to take photographs of the plants.

HAEMANTHUS AVASMONTANUS IN FULL SUMMER GROWTH EARLY FEBRUARY 2010

The next field trip took place on 6 February 2010. The conditions were ideal for the *Haemanthus* owing to the good regular rains in the previous two months. Several hours were spent at various colonies and sub-colonies carrying out detailed autecological research and extensive photography.

It was found that the plants were more numerous than initially suspected, and also that they occupied a multiplicity of niches on south-facing aspects of the mountain. In one case a few *Haemanthus* were found

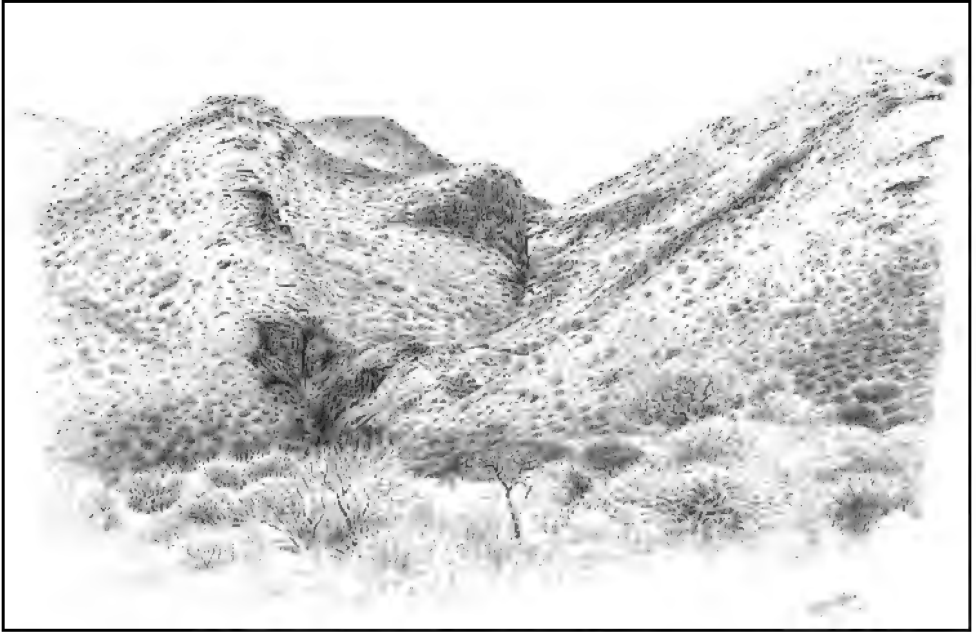


Fig. 1. A pencil drawing by Gerhard Marx of the Otjihaveraberg north of Windhoek in central Namibia. *Haemanthus avasmontanus* is found mostly on broad south-facing cliff ledges such as those at the bottom and top of the mountain. Pencil is a most expressive medium for capturing the arid convolutions and gorges of this mountain range.



Fig. 2. The Otjihaveraberg north of Windhoek photographed on 8 February 2010 after good summer rains. The typical habitat occupied by *Haemanthus avasmontanus*, consisting of sheer rock faces and broken cliffs above a gorge is visible in the middle distance of this photograph.



Fig. 3 Typical convoluted rocky slopes and the distinctive peaks above them which characterise the Otjihaveraberg near Windhoek. Suitable habitat for *Haemanthus avasmontanus* is found on the lower slopes in the foreground as well as the elevated peaks in the distance. This photograph with its clouds and dappled light on the mountain resembles a Pieterneef painting.



Fig. 4. Typical cliff faces frequented by *Haemanthus avasmontanus* on the Otjihaveraberg. The species is absent from the north-facing slopes clad with trees and grass in the background.



Fig. 5. *Haemanthus avasmontanus* grows as a cremnophyte in closely packed groups of bulbs on the ledges of south-facing cliffs. The black areas on the ochre-coloured rock face indicate seepage areas and the *Haemanthus* are entirely confined to these situations.



Fig. 6. *Haemanthus avasmontanus* is unable to compete with grasses for growing space as clearly indicated in this photograph. A group of bulbs of various ages is visible on the relatively grass-free cliff ledges in the foreground but none were present on the grassy slope in the background to this photograph.

on a rocky north-facing slope opposite south-facing habitat with the full range of niches frequented by the bulbs. These bulbs grew in deep shaded recesses well protected from direct sunlight. They occurred in deep soil pockets amongst rock fragments that had fallen off the cliffs above. It was curious how these bulbs arrived here in the first place, and it seemed likely that the seeds from which they germinated were carried there by Rock Hyraxes or rodents. (The latter is discussed in more detail below.)

NICHES OCCUPIED BY *HAEMANTHUS AVASMONTANUS* ON SOUTH-FACING CLIFFS AND SLOPES

Haemanthus avasmontanus owes its success as a species to its adaptability to a multiplicity of niches in its habitat. These are soil filled cracks and ledges on sheer rock faces, broad ledges with deep soil on broken cliffs, steep rocky slopes with fixed rocks and stepped rocky seepage areas beside streams. All these places share the same characteristics. They retain moisture for long periods after good rains and are furthermore irrigated by seepage from above for several days or possibly weeks after good summer rains. None of these niches is densely utilised by grasses or annual herbs which compete with the *Haemanthus* for light and nutrients. The *Haemanthus* is adapted to shady conditions whereas its potential competitors are not. The bulbs are, as a result, hardly ever found on steep grassy slopes even if these are in shade for the greater part of the day.

The bulbs share their habitat with various fern species, an unidentified *Oxalis* species, and various shade loving *Crassula* species.

The niches in which the *Haemanthus* occur are discussed in more detail below.

Sheer rock faces

This type of habitat is fairly rare on the Otjihaveraberg but densely utilised where it occurs. The *Haemanthus* grow as cremnophytes in these places, the bulbs colonising every available niche with enough soil to accommodate the relatively small bulbs. The distribution of the plants in this type of habitat is clearly shown in the photographs that accompany this paper. The black areas on the ochre-coloured cliff-face indicate seepage sites after rainfall, and it is here where the bulbs grow. These places often have very little soil, and plants are wedged into cracks in the rock where they become laterally compressed as they age. The bulbs are occasional

away from the main seepage sites, but the best irrigated sites are densely used by the *Haemanthus*.

Broad ledges with deep soil on broken cliffs

This was by far the commonest niche occupied by the *Haemanthus* in the habitats examined. In situations where ledges were at least 60 cm wide, with few rock fragments buried in the soil on them, the bulbs grew close together in clumps of 6 to 15 individuals. In places where the depth of soil was restricted vertically and laterally by rocks, the bulbs occurred singly or else in small groups of 2 to 4 wherever space permitted these small clumps to develop. Fissures in seams of schist were also densely used where there was little soil on wide rocky ledges.

Stepped rocky hillsides

This habitat was found to be infrequent. It usually consisted of small rock faces about a metre or less high below which were ledges 60 to 90 cm wide followed by another one or two cliffs below with the same habitat.

The deep soil on these ledges was heavily colonised by the bulbs which generally occurred in numbers of 20 to 30 individuals, occasionally more. This habitat, frequently at the base of steep hills just above watercourses, retained the most moisture after rainfall in the area. In some cases all available niches were colonised by *Haemanthus* bulbs.

Steep rocky slopes with fixed rocks

This sort of habitat was widely scattered over boulder-strewn grassy hillsides and contained the fewest numbers of the *Haemanthus*. The reason appeared to be related to the fact that these sites were densely used by grasses and shrubs leaving few open places for the bulbs to thrive. These tended to dry out quickly after rainfall as the moisture was rapidly used up by other plants.

Competition from other plants and lack of moisture, even in these south-facing positions, seemed to exclude the *Haemanthus* from this type of habitat. The bulk of the countryside, in south-facing positions, consisted of this sort of terrain. In effect this severely restricted the overall amount of suitable niches available for colonisation by the bulbs.

THE GROWTH CYCLE AND RECRUITMENT OF YOUNG PLANTS TO THE POPULATION
Haemanthus avasmontanus begins its growth cycle with the onset of the main summer rains which can be any time from early December to early February. The plants come into flower at the same time as the new leaves emerge and usually have fully ripened berries ready for dispersal about 6 weeks after the first good summer rains.

The species probably had good and poor flowering seasons, and it was extraordinary to discover that this was not necessarily related to summers of drought and good rainfall. The 2009-2010 rainy season was very good following similar conditions the previous year in 2008-2009. Yet only four plants had flowered in widely scattered colonies in the 2009-2010 season. Only two of these had one developing berry per plant on 6 February, the day the data was collected.

The bulbs are likely to flower only during years of average or above average rainfall in between successive seasons of drought.

The leaves have attained their maximum length by the time the berries ripen, probably well before this. They remain green until late April, quickly withering as the habitat dries out and night temperatures in the gorges where they grow, become cooler. Dry weather during March and April implies that the plants enter dormancy more quickly.

Recruitment of new plants to the population was found to be good across the four habitat types but with the greater number of young plants observed on broad ledges with broken cliffs and stepped rocky hillsides. Young plants were easily recognised as for the first few seasons after germination they only have one leaf. The length and width of the single leaf allows deductions to be made as to when young bulbs germinated. Seedlings of uniform size are often noted indicating germination events after a good seed set.

Preliminary indications are that the flowers are strongly self sterile, and that the best seed set occurs during years of mass flowering. The factors which trigger mass flowering are not yet clear but are probably related to a few consecutive dry years broken by good rainfall.

The berries are very similar to those of *Haemanthus montanus* and are suspected to be distributed via several methods. Some may fall around the parent plants where they germinate, whereas others are moved about the environment after rainfall. It is impossible that seeds that germinate in some places on cliff faces or in various rocky niches could have done

so without some animal vector. The seeds are likely to be unpalatable but carried nevertheless by rodents or Rock Hyraxes to rocky situations before they are discarded. Bulbs growing on northern slopes probably also owe their existence to this type of seed distribution.

LAND USE PATTERNS IN THE MODERN HABITAT

The Otjihaveraberg and surrounding arid thornveld are used for cattle ranching and game farming. In recent times the parts of the mountain range around Dobra, not far north of Windhoek, have been extensively settled by the local people. This has resulted in the extinction of the *Haemanthus* from places which it was once known to frequent. (Inge Pehlemann, personal communication, February 2010).

The area which formed the focus of research was used only in a minor way for cattle ranching. The animals grazed primarily in grassland in valleys with seasonal streams and more frequently on grassy hillsides. They avoided the entire habitat recorded for the *Haemanthus* since these places were largely inaccessible to large grazing animals. Stock of this nature made no difference at all to the *Haemanthus*, and the bulbs were at their optimum level of occurrence in all the habitats examined.

Some bulbs with nibbled leaves were encountered occasionally, always near rocks and cliff faces, although there were no direct observations the browsers concerned appeared to be Rock Hyraxes. Leaves were probably eaten at the beginning of the season when the habitat was still brown and sere after the winter drought, and when little greenery had emerged in any abundance. Once the rains were under way the *Haemanthus* were neglected in favour of more palatable food sources.

The habitat would be extremely vulnerable to changes in land use should goat ranching be introduced. These animals readily graze and trample all the habitat types recorded for the *Haemanthus* in this research except for sheer cliff faces.

FURTHER RESEARCH

It is unknown at this stage as to what extent the distribution of *H. avasmontanus* is even across suitable habitat on a given mountain range. If the distribution of colonies is generally sparse, the species may be very rare indeed. Surveys are required in the Auasberge, the mountains in the vicinity of the Bismarckfelsen and the hills and mountains around Groot

Aub. It may also be that the plants occur in the more elevated parts of the eastern Khomas Hochland.

COMPARISONS WITH, AND CONTRASTS FROM, THE AUTECOLOGY OF *HAEMANTHUS MONTANUS*

Haemanthus montanus is a well distributed plant in the eastern South African interior, and there are several similarities between the autecology of this plant and that which characterises *H. avasmontanus*. Both grow gregariously in widely scattered colonies and come into flower as the leaves start to emerge at the beginning of the main summer rains. In both instances the plants have good and poor flowering seasons. In the case of *H. montanus* this varies from one year to the next, but it usually follows a previous wet season followed by winter grass fires which clear the veld of moribund vegetation.

Haemanthus avasmontanus grows in well drained friable soil that retains moisture by virtue of the fact that it is located over rocks.

Haemanthus montanus grows in clayey soil that often remains water logged for weeks on end during the growing, flowering and fruiting season.

Haemanthus montanus grows in sunlight in moist grassy wetlands usually associated with seasonal streams or vleis, whereas *H. avasmontanus* is a plant of shaded rocky south-facing cliffs and steep slopes.

The seeds of both species are very similar, varying only in size. In contrast to other *Haemanthus* species the berries are enclosed in a thin somewhat elastic covering which dries out at the time they are ready to germinate. Other *Haemanthus* species have their berries encased in a dense spongy covering which becomes progressively more fragrant as the seeds ripen.

ACKNOWLEDGEMENTS

I would like to thank Inge Pehlemann, a resident of Windhoek in Namibia, whose inputs and insights contributed in a large measure to the success in locating the plants. I am grateful to Connall Oosterbroek for contributing the extensive photographic record, some of which accompanies the text in this paper.

I would like to thank Dawie Human for his company during fieldwork in May 2009 and February 2010. Dawie helped locate all the colonies in the field on which the autecological research was based.

Dr. Piet Vorster is thanked for his constructive comments on the manuscript.

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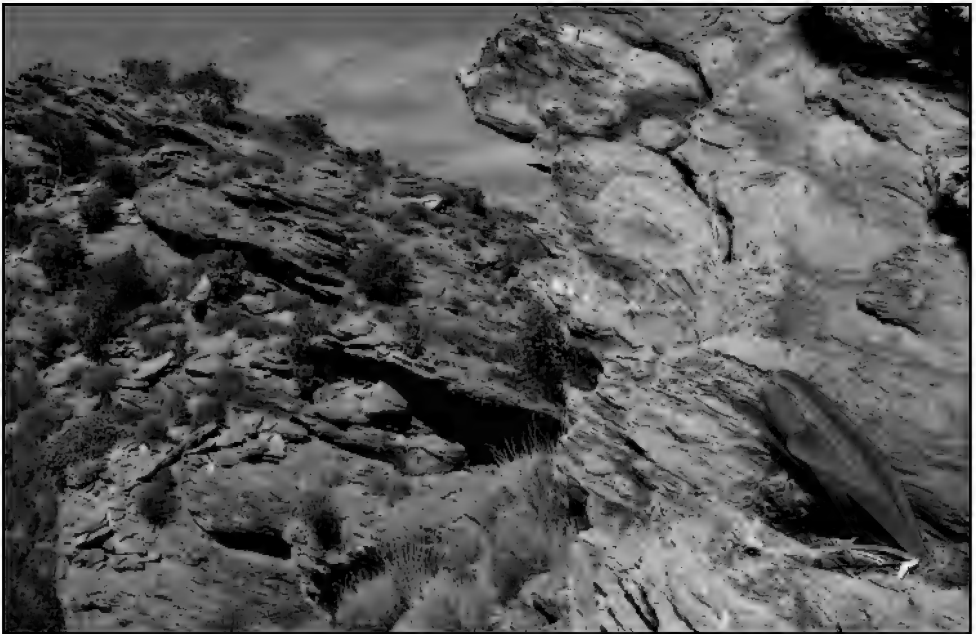


Fig. 7 *Haemanthus avasmontanus* is a plant found mainly in places which receive a few hours of dappled sunlight per day in the growing season. Occasionally plants grow on east-facing ledges and in these instances the colonies consist mainly of large mature bulbs in deep soil pockets. There is little possibility for new plants to develop from seed as in the majority of summers this type of habitat is too dry.



Fig. 8. A watercolour painting of *Haemantthus avasmontanus* in its habitat by artist Gerhard Marx. The plants grow as cremnophytes in most places, tightly packed in small or large groups on south-facing cliff ledges. This painting depicts typical habitat in a gorge of the Otjihaveraberg in central Namibia.



Fig. 9. These two *Haemanthus avasmontanus* are amongst the largest sizes reached by the species. One of the plants has flowered, the only one to do so in the 2009-2010 summer in an extensive widely scattered colony. The inflorescence and stem were withering when photographed on 6 February and none of the flowers had been successfully pollinated. A *Crassula* (species unidentified) often grows with the *Haemanthus* on ledges that receive dappled sunlight for part of the day.



Fig. 10. (Above) *Haemanthus avasmontanus* often grows together with an *Oxalis* species in situations where the *Haemanthus* occurs in narrow fissures between rocks.

Fig. 12. (Below) *Haemanthus avasmontanus* grows in niches with the deepest soil on rocky ledges whereas places with shallow soil are invariably only colonised by *Crassula* or fern species.





Fig. 11. The niches on cliff ledges crammed with loose and fixed rocks limit the number of places where the bulbs can grow. Bulbs in these places mature very slowly owing to the limited soil depth.



Fig. 13. Ledges with pockets of deep soil, uncluttered with rock fragments, and densely utilised by the *Haemanthus*. Ferns are the only other plants which occur on heavily shaded ledges and these plants offer no competition to the bulbs.



Fig. 14 A typical group of *Haemanthus avasmontanus* in a rocky fissure. These places often have only enough space for 3 to 5 bulbs to grow and mature.



Fig. 15. *Haemanthus avasmontanus* seeds often germinate best at the upper edges of seepage areas below cliffs. These places retain moisture the longest after rainfall.



Fig. 16. The leaves of all these *Haemanthus avarum* were nibbled by Rock Hyraxes, in all probability, early in the growing season. Very few plants had chewed foliage and only in rare cases had more than half the length of the leaves been eaten.



Fig. 17 *Pseudogaltonia* (fam. Hyacinthaceae) is common in arid sun drenched north-facing habitat on the Otjihaveraberg. The plants nearly always grow in large groups quite unlike their occurrence as solitary plants in the sandy areas they frequent around Windhoek.



Fig. 18. A *Euphorbia* species, probably *Euphorbia virosa*, is found in abundance on the hot arid north-facing slopes of the mountain. This species is nearly always an indication of where *Haemanthus avasmontanus* is not found.



Fig. 19. In cases when *Haemanthus avasmontanus* is not going to flower the tip of one of the two leaves always seems to emerge before the other.

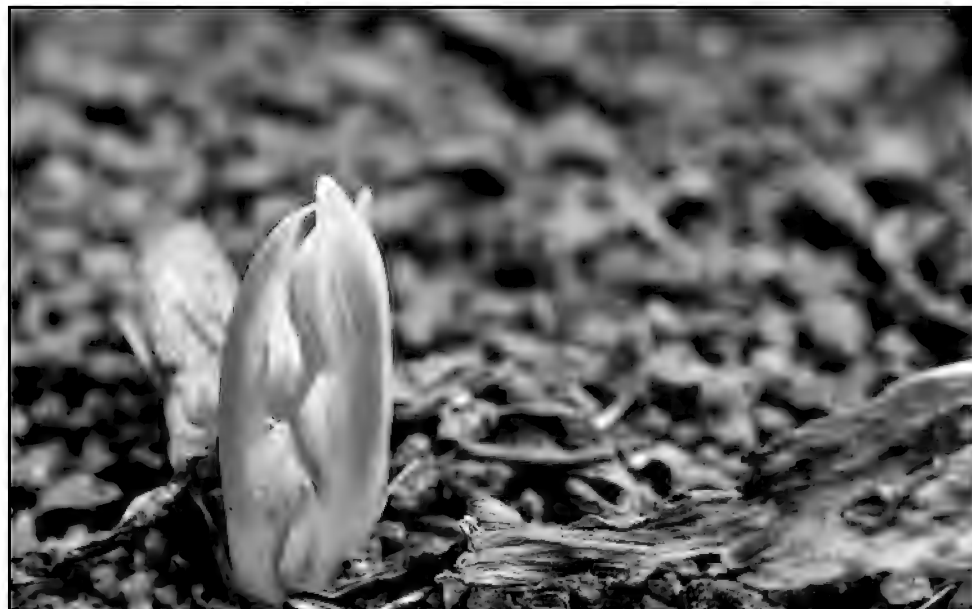


Fig. 20. *Haemanthus avasmontanus* buds emerge well before the leaves which push through the soil about 7 – 10 days later.



Fig. 21. *Haemanthus avasmontanus* flower buds develop quickly and some flowers are nearly ready to open before the stem supporting the inflorescence has grown to its full length.



Fig. 22. *Haemanthus avasmontanus* in full flower, displaying many differences between the flowers of this species and *Haemanthus montanus*.



Fig. 23 The outermost *Haemanthus avasmontanus* florets wither first usually shortly after pollination and as the seeds start to develop.



Fig. 24. *Haemanthus avasmontanus* in full flower.



Fig. 25. Eggs of the Amaryllis caterpillar *Brithys pancratii* laid on the side of a *Haemanthus avasmontanus* leaf. The eggs turn black after a few days and the caterpillars hatch out causing complete destruction of the leaves and even boring into the bulb.

**ORNITHOGALUM LEBEAENSE, A NEW CLIFF DWELLING
ORNITHOGALUM (HYACINTHACEAE) FROM
SOUTHWEST ANGOLA (BENGUELLIA PROVINCE)**

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ABSTRACT

Ornithogalum lebaense Van Jaarsv. from sheer rock faces of the Serra da Chella escarpment west of Lubango in southwest Angola is described. It is at once distinguished from all other *Ornithogalum* species by its pendent leaves and inflorescence, the latter in fact a unique feature among the genus *Ornithogalum*.

INTRODUCTION

The bulbous genus *Ornithogalum* L. (sensu Obermeyer 1978) consists of about 200 species of which most are confined to sub-Saharan Africa; about half are confined to Southern Africa, particularly to the Cape Floristic Region (Obermeyer 1978; Manning et al. 2004). Recent field studies on cliffs associated with the escarpment mountains in southwest Angola revealed a unique new cliff-dwelling, winter-flowering species described below. *Ornithogalum lebaense* belongs to subgenus *Urophyllon* (Salisb.) Baker, a group of about 30 species (sensu Obermeyer) which grow mainly in the summer rainfall region in southern Africa. This group is characterised by its ovate-acuminate aristate bracts, white or green perianth segments, 3–7 nerved midrib, ovoid capsules and seeds which are angular, semi-lunate, and colliculate (Obermeyer 1978, Manning et al. 2009). *Ornithogalum lebaense* is an obligatory cremnophyte only known from sheer cliffs along the escarpment mountains (Serra da Chella) west of Lubango in southwest Angola. Plants grow in rock crevices with the bulbs, leaves and inflorescence growing pendent (Fig. 1). It is at once distinguished by its flaccid, succulent, linear-attenuate glaucous-green

leaves, distinct short conical inflorescence, white flowers and conspicuous long acuminate, white-coloured bracts.

***Ornithogalum lebaense* Van Jaarsveld sp. nov.**

Ad *O. longibracteato* Jacqu. foliis inverno deciduis differt. Folia glauca, fere succulenta, mollia, flaccida, lineari-acuminata, spiraliter curvata, 700-820 x 25-35 mm metientia. Inflorescentia brevis, pendens, 200-300 mm longa, racemo conico.

TYPE: **Angola**, 1413 (Lubango): Cliffs overlooking Leba Pass, between Namibe and Humpata, (–DC), 19 Jan 2009, Van Jaarsveld **22611** (holotype LUB; isotype NBG, WIND).

Description:

Plants bulbous, winter deciduous, hypogeous or semi-epigeous, solitary or dividing and forming small clusters up to 100 mm diameter. *Bulbs* globose-ovoid, up to 30-40 x 20-30 mm; tunics white, fleshy and somewhat translucent; outer tunics drying greyish, bearing dark transverse ridges towards the neck; roots whitish, less than 1 mm in diameter. Leaves 4-5, synanthous, 700-820 x 25-35 mm, pendent, spirally curved, semi-succulent soft and flaccid, linear-acuminate and channelled, terete at the apex; surface glaucous, somewhat translucent, smooth, striate, slightly grooved, margin entire; apex acute; juvenile leaves linear, subterete, softly succulent. Inflorescence 200-300 mm pendent, 1-2 per plant. Raceme conical, 80-140 x 55-70 mm long (multi-flowered); scape terete, 120-150 mm long, about 5 mm in diameter at base and inflating to 10-15 mm in diameter at the centre tapering again in upper half, and same colour as leaves; bracts conspicuous, attenuate-lanceolate, cymbiform, white (bearing a median green stripe), clasping pedicle and channelled; older bracts remain functional until inflorescence reach expires; lower bracts 45-60 x 6-7 mm, becoming smaller upwards. Lower pedicel 12-17 x 0.7-1.0 mm, becoming shorter upwards, the lower pedicles lengthening in fruit to about 30 mm. Flowers densely arranged (35-50); perianth stellate, white, 20 mm in diameter, sweetly scented; tepals spreading, white and bearing a greenish median band, ovate-elliptic, 8-11 x 4-5 mm. Stamens 8 mm long; filaments white, linear and with abrupt lateral extensions in lower half and 1.5 to 2 mm in diameter; anthers 2 mm long. Pollen white. Ovary yellowish green, trigonous, ridged, abruptly tapering at apex, 4.5 x 4.5 mm.

Style 3 mm extending to 5 mm when mature, yellow, erect, white; stigma apical papillate. Capsule 7-9 × 7-9 mm, trilobate. Seed flattened, black, angular, semi-lunate about 4 x 2 mm, colliculate, epidermis shiny.

Phenology

Ornithogalum lebaense flower during winter (June-August) and during which the leaves becomes dormant. Seeds are dispersed by wind during spring (September onwards).

Distribution and habitat

Ornithogalum lebaense (Figures 1, 2) is known only from exposed vertical quartzitic sandstone cliffs (north-east facing) along the inland escarpment mountains (west of Lubango). The vegetation of the region consists of grassland (upper slopes), miombo (dense savannah rich in *Brachystegia*) and Afromontane Forests along the escarpment margin and in sheltered kloofs. It grows on cliffs below the spectacular lookout point at Leba Pass at altitude of about 1800 m (Fig. 3-5). The plants grow scattered, sharing their habitat with cremnophilous species such as *Albuca* sp., *Aloe mendesii*, *A. vallis*, *Crassula lanceolata*, and *Kalanchoe lanceolata*. The climate is subtropical, and with mild frost free winters. The northwest facing cliffs have shady conditions in the morning and full sun during the afternoons. The mainly summer rainfall ranges from ± 1000-1500 mm per annum. Summer temperatures are high during the day. Plants are pollinated mainly by insects.

DISCUSSION

The genus *Ornithogalum* and related genera in the Hyacinthaceae have recently been reviewed (Manning et al. 2004; Manning et al. 2009). Molecular techniques by these authors have been applied to rearrange species within the Ornithogaloideae, and accordingly, the subgenus *Urophyllum* (Salisb.) Baker to which *O. lebaense* belongs has now been accommodated within the genus *Albuca*. *Albuca cremnophila* Van Jaarsv. & Van Wyk and *A. thermarum* Van Jaarsveld were recently named (Van Jaarsveld & Van Wyk 1999, 2003). On grounds of molecular findings, these two taxa were then transferred to the genus *Ornithogalum* (Manning et al. 2004) but again transferred back to *Albuca* in their later paper (Manning et al. 2009). In naming *Ornithogalum lebaense*, the author decided to follow

earlier works such as Obermeyer (1978) as to avoid further confusion and until stability has been reached in molecular techniques. The purpose of plant classification is to bring order and clarification, ultimately stability, aiding in the ease of classification. However, the main motivation of this recent published paper (Manning et al. 2009) again was based on molecular work, resulting in the toppling the historical sound and solidly based classification system.

Ornithogalum lebaense is one of four *Ornithogalum* species recorded for Angola. The other species includes the widespread *Ornithogalum tenuifolium*, *O. pulchrum* and *O. benguellensis* (Figueredo & Smith 2008). From these species (and all others) it can at once be distinguished by its long pendent, flaccid glaucous leaves and short pendent conical inflorescence of densely arranged flowers and conspicuous white coloured bracts, the latter of which are in fact longer than the flowers and their pedicles. *Ornithogalum lebaense* (and the other mentioned Angolan species) clearly belongs to subgenus *Urophyllum* and is related to a group of xerophytic summer-rainfall species in the north. Its short pendent, condensed inflorescence is unique among the *Ornithogalum* species.

Ornithogalum lebaense is an obligatory cliff dweller. It was collected by the author on an expedition to southwest Angola in January 2009 (Fig. 3), a capacity building project arranged by Brian Huntley, former Director of the South African National Diversity Institute (Van Jaarsveld 2009). The cliffs below the lookout point at the top end of Leba Pass were visited and inspected, and the plant was spotted growing among *Aloe mendesii*, another obligatory cliff dweller of the escarpment mountains (Fig. 6). Live plants of the new species were obtained with difficulty due to the sheer nature of its habitat (Fig. 5). These plants were grown at Kirstenbosch National Botanical Gardens, and when they came into flower in June 2010 (Fig. 7-8), a plant was illustrated by Vicki Thomas, botanical artist (Fig. 1). Fortunately both of the two collected plants flowered, and hand pollination resulted in good fruit set.

The author's interest is obligatory cliff-dwelling succulent and bulbous species in Southern Africa which he has grown and studied for the past 10 years. Cliffs, due to their hazardous nature, remain one of the most pristine habitats in the world (Van Jaarsveld 2003). Although plants grow in habitats largely undisturbed by larger herbivores, the nature of the habitat poses a challenge to long term survival of any life forms on the



Fig. 1. *Ornithogalum lebaseense*, illustration of a plant in habitat (life size). Artist Vicki Thomas.

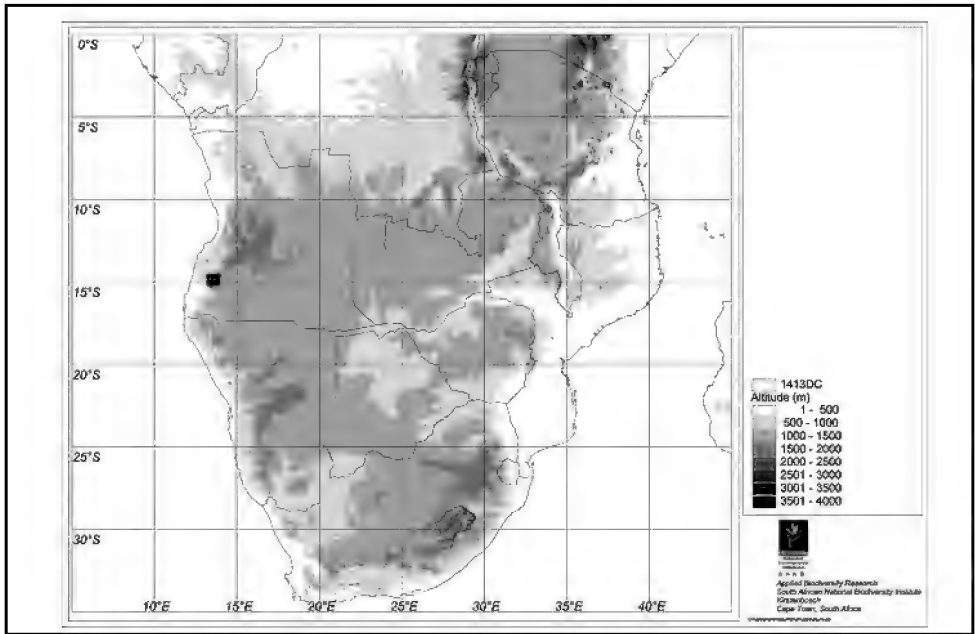


Fig. 2. Known distribution of *Ornithogalum lebaense* (black rectangle).



Fig. 3. Close-up of *Ornithogalum lebaense* plants in habitat at Leba Pass.

vertical habitat. Some plants become obligatory cliff dwellers, whilst others grow opportunistically. Growth space is usually limited, runoff rapid and the ever present force of gravitation. Some plants such as our new species and its associated *Aloe mendesii*, solve this problem by pendent growth (cliff hangers, surrender to gravity). Reproduction on cliffs also poses a problem, and although most cliff dwellers have rich flowering (attracting pollinators) and seeds which are wind dispersed, many also have an additional vegetative back-up reproduction. Some produce bulbils which become detached and colonise new crevices. In South Africa and Namibia about 220 species (obligatory or near obligatory) have been identified. Of these, 9 species belong to the Hyacinth Family (Hyacinthaceae), of which three belong to the genus *Ornithogalum* (the remainder *Albuca*). The first, the evergreen, pregnant onions (*Ornithogalum longibracteatum*) are the most widespread (mainly southern and eastern parts of South Africa) and are commonly found as a pot plant throughout the world, spreading by numerous bulbils produced at the base of the bulb. Although commonly encountered on cliffs, bulbs grow on non-cliff habitats as well. The bulbils grow epigenous and the outer bulb scales are photosynthetic active. The plant has an ascending growth with a tall inflorescence up to 150 mm long. The two other, obligatory cremnophytic *Ornithogalum* species include *O. pendens* (winter growing) recently named from the Skaaprivierspoort in Namaqualand (northern Cape, South Africa, Van Jaarsveld & Van Wyk 2009) and *Ornithogalum juncifolium* var. *emsii* (eastern Cape, Van Jaarsveld & Van Wyk 2005). The latter also produce their bulbils on top of the substrate and proliferate from the base forming numerous bulbils.

The leaves of *O. lebaense* are spirally curved, glaucous and the same colour as the leaves of *Aloe mendesii*, its cliff associate. The leaves wither during winter at anthesis, becoming pinkish brown and deciduous. One to two inflorescences are produced in succession. The young inflorescence grows tightly infolded within the encircled basal portion of the leaves. The flowering period is about 30-45 days. The conspicuous, long-white colouring bracts remain functional until the last flower expires, and as an example of 'rich flowering', maximises its visibility to attract pollinators. Experiments in cultivation show that unfertilised flowers abort. Leaves appear during November (late spring). The fruiting capsules ripen from early spring (August), the light, flattish black, semi-lunar to angled seeds are shaken from the capsules and are wind-dispersed.

Cultivation

Ornithogalum lebaense is easily grown from seed sown during spring or summer. It thrives well in cultivation but should be kept dry during winter. It is best to grow plants in mineral-poor sandy soil and fed with an organic fertiliser. The drooping nature of the leaves and inflorescence should make it an ideal hanging basket subject.

Etymology

The specific epithet *lebaense* pertains to Leba Pass, its habitat.

ACKNOWLEDGEMENTS

Brian Huntley for making available the opportunity of visiting Angola. I thank Dr O.A. Leistner for editing the manuscript, John Lavranos for translating the diagnosis into Latin, Leslie Powrie for assisting with preparing the distribution map, and my colleagues Adam Harrower, Phakamani Xaba, Karin van der Walt and Werner Voigt for their assistance in the field during our Angolan expedition in January 2009. I am also grateful to Vicki Thomas for the colour illustration.

All photographs by the author.

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Fig. 4. Close-up of *Ornithogalum lebaense* plants in habitat at Leba Pass.

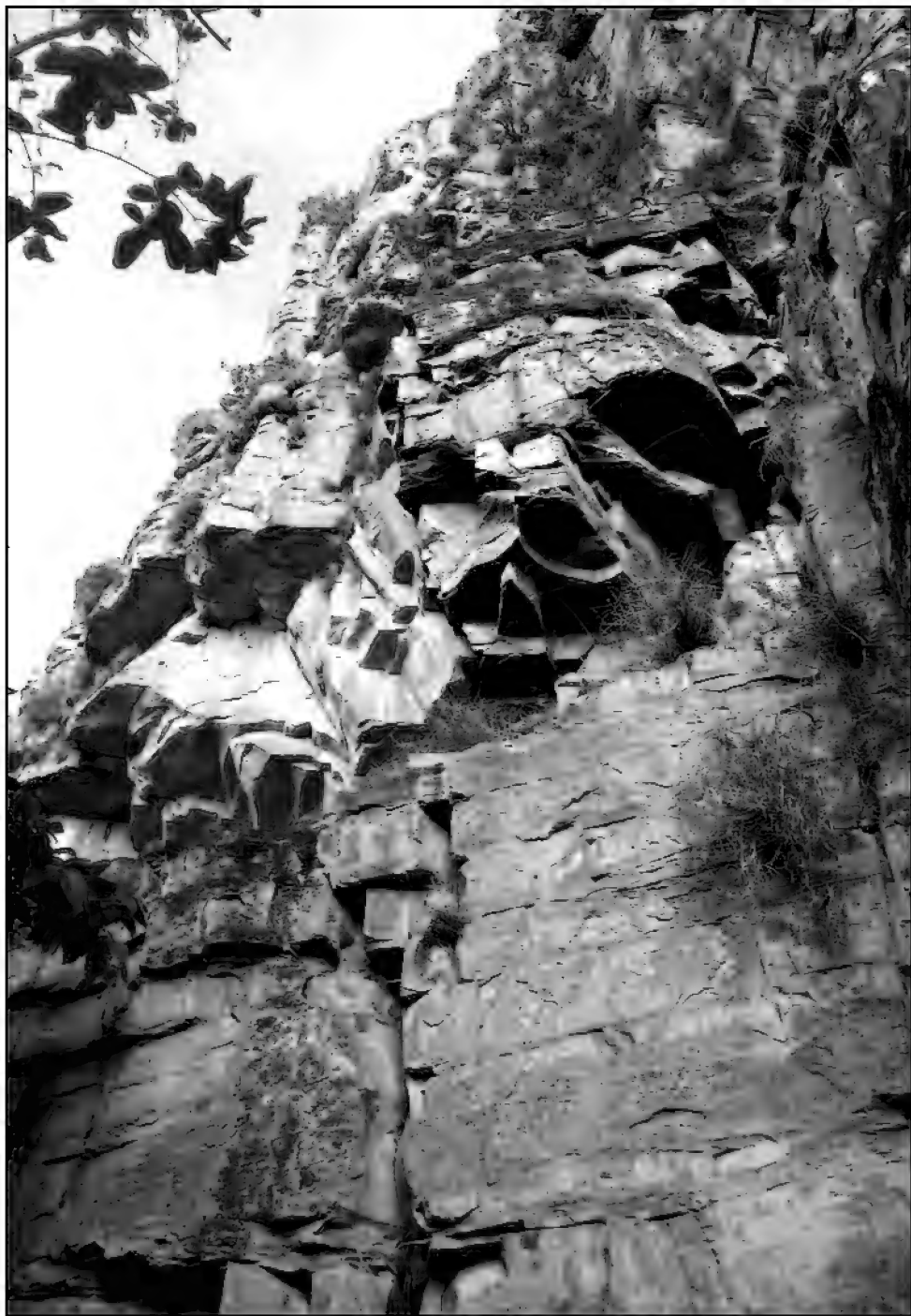


Fig. 5. The cliff face habitat of *Ornithogalum lebaseense* at Leba Pass.



Fig. 6. *Ornithogalum lebaense* sharing its cliff habitat with *Aloe mendesii* at Leba Pass.



Fig. 7. Inflorescence of *Ornithogalum lebaense* in flower at Kirstenbosch National Botanical Garden (western Cape, South Africa).



Fig. 8. *Ornithogalum lebaense* in flower at Kirstenbosch National Botanical Garden (western Cape, South Africa).

CRINUM ROPERENSIS, A NEW SPECIES FROM AUSTRALIA (AMARYLLIDACEAE)

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INTRODUCTION

In late November 2008, the authors, accompanied by Nancy Lehmiller, set out upon a one week sojourn in Northern Territory, Australia, for purposes of studying the regional indigenous *Crinum*. A partial account of our travels was previously reported (Lehmiller, 2008). We began our adventure in Darwin, traveling generally to the south and to the southeast. The weather was hot and humid, but we were greeted with greenery in the local ecology, an indication of recent summer rainfall.

Having spent the fourth night of our journey in the inland city of Katherine, we drove south on the Stuart Highway, noting populations of *Crinum angustifolium* R. Brown on the outskirts of the city limits. Just beyond Mataranka, we turned east onto Roper Bar Highway, a single-lane, partially sealed road paralleling Roper River and leading to Roper Bar Crossing and Arnhem Land (Aboriginal homeland territory). Near Elsey Creek we again saw a few *Crinum angustifolium*. Then just past Cheon Creek, we spied something different: a starry appearing, single white flower on a scape from a plant far too large to be *Crinum uniflorum* F. Mueller.

This *Crinum* taxon was scattered along both sides of the road, growing in reddish sandy soil with a clay subsoil, amongst scrub brush with trees further removed from the road (Fig. 1-2). The bulbs appeared to prefer moisture-rich spots in the Savannah terrain and a sunny exposure. The *Crinum* population extended intermittently for at least 5 km along the highway. Only sporadic bulbs were blooming with many just recently coming into leaf, and we did not observe any in seed. Most umbels were

uni-flowered, with occasional bi-flowered umbels and a single tri-flowered umbel recorded. Leaves formed a rosette, with flowering bulbs bearing 5-9 low-arching leaves. Individual leaves exhibited a small depressed midrib effect, were modestly channeled, and bore minute teeth on their margins. A flowering size bulb measured 4 cm in diameter with a 10 cm long underground neck. This was an undescribed species possibly allied to *C. uniflorum*; it was an exciting moment.

***Crinum roperensis* Lehmiller and Lykos, sp. nov.**

Species nova a *C. unifloro* foliis latioribus, costam medianam depressam, marginibusque denticulatis distinguenda.

Type: **Australia.** Near Cheon Creek*, Roper Bar Highway, Northern Territory (S14 45.307, E134 13.216). Original collection 2 December 2008; ex hort. June 2010, Lehmiller and Lykos **1955**. (Holotype: TAMU; Isotype: pending) (Fig. 3-6).

(*Note: Cheon Creek is a branch of Fizzer Creek, the latter being a tributary of Roper River.)



Fig. 1. Habitat of *Crinum roperensis*, December 2, 2008.



Fig. 2. *Crinum roperensis* in flower, December 2, 2008.

Description:

Bulb ovoid, covered with a brown papery tunic, 4-7 cm in diameter, having an underground neck 6-10 cm long; offsets sometimes occurring. Leaves 5-9, arising at ground level without a pseudostem, forming a low arching rosette with newer leaves clasped by their predecessors, with occasional mature older leaves lying on the ground, widest near the base and slowly tapering to a slender point, mild to moderately channeled with a small depressed midrib effect that is more expressed in the proximal leaf, non undulate, margins bearing spaced minute denticulations, faint longitudinal parallel grooves visible on both leaf surfaces, containing tiny wooly fibers when torn apart, shiny green, maximum length 34-58 cm, maximum width 1.5-2.8 cm. Scape arising from the ground, dull light green sometimes with a reddish tint near the base, ovoid, 17-31 cm long. Spathe composed of two principal bracts, spreading and beginning to wither or drooping and completely withered at anthesis, light green, 4.5-10.3 cm long by 0.9-1.6 cm wide. Umbel 1-3 flowered; flowers nearly actinomorphic, white and starry appearing, pedicel length 0-1.5 cm, opening at night, light pleasant scent. Buds initially erect, moving to a vertical drooping stage the day before anthesis, and then becoming erect or nearly erect at anthesis. Ovary shiny dark green, 1.0-1.8 cm long by 0.6-0.8 cm diameter. Perianth tube either straight at anthesis or with a slight distal curve, light chartreuse green becoming almost whitish distally, 9.5-14.0 cm long. Segments narrowly lanceolate, white, unequal with the outer usually slightly longer, not distally recurved, 6.8-10.9 cm long by 1.3-2.1 cm wide; apiculate, with the outer segment apiculates more prominent, 4-8 mm long, white to light green colored. Filaments spreading and bowed, unequal with the inner slightly longer, distally purple and proximally white, 5.4-7.3 cm long; anthers near centrally inserted, crescent shaped at maturity, pollen golden yellow. Style purple with sometimes a trace of white at the throat, 4.5-9.2 cm long; stigma small capitate with 3 lobes. Fruit globular with 6 vague end-to-end grooves, bearing an apical rostellum 1.5-5.5 cm long, dull light green, with pericarp becoming papery thin and turning tan colored at maturity, 4.0 x 3.5 x 3.2 cm to 5.0 x 4.3 x 4.0 cm in size, indehiscent; seeds 20-29 per fruit, variable in size and shape with compression changes due to adjacent seeds, pale light green, 0.8-2.2 cm maximum dimensions.

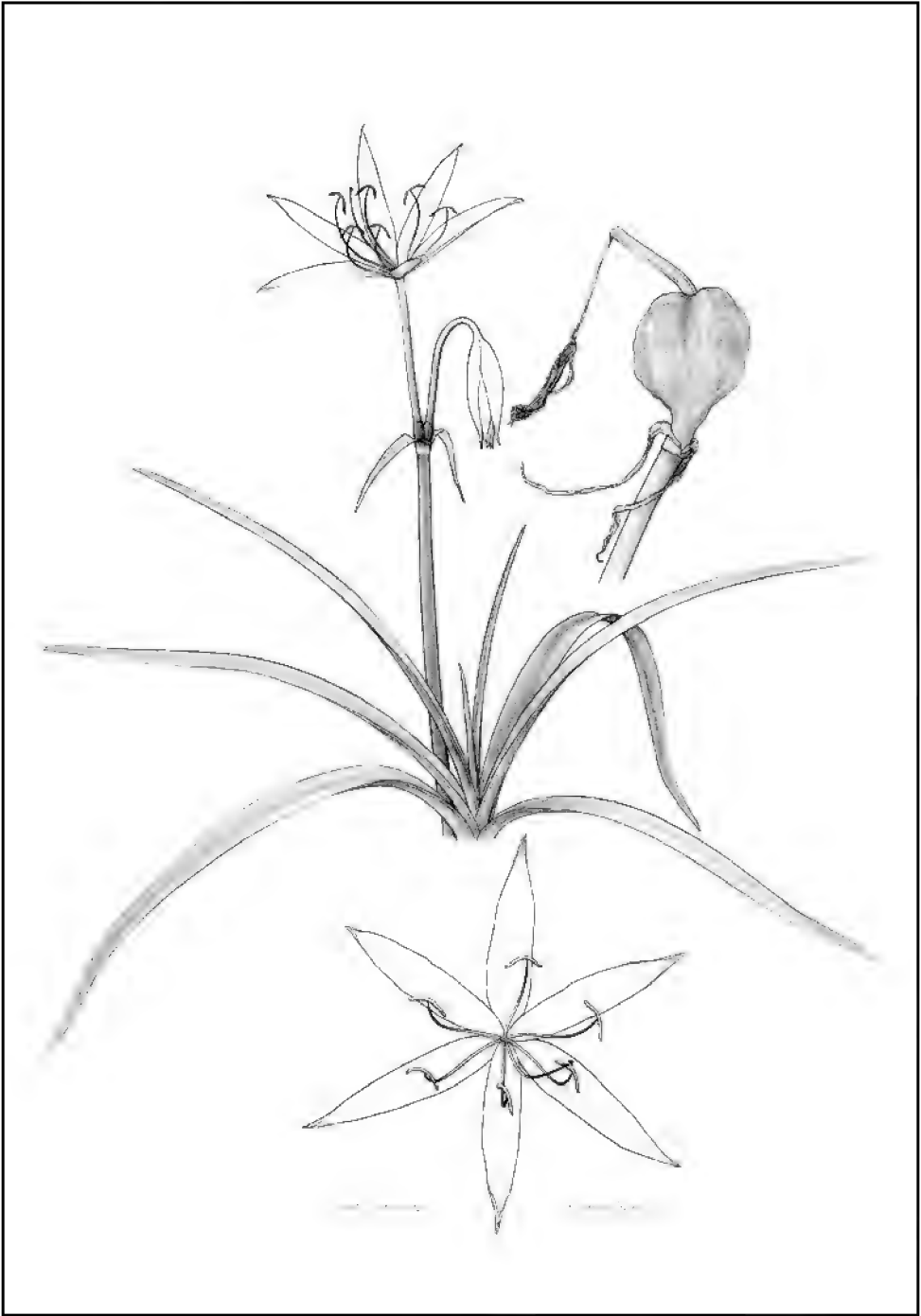


Fig. 3. Illustration of *Crinum roperensis* by Kristin Jakob



Fig. 4. Type specimen of *Crinum roperensis* ex hort., Lehmiller & Lykos 1955 (TAMU).



Fig. 5. *Crinum roperensis*; the flower is the type specimen ex hort., Lehmiller & Lykos 1955. An earlier scape (upper right) is beginning to develop a fruit (seed pod).



Fig. 6. Close-up of the flower of *Crinum roperensis* in Figure 5.



Fig. 7. Comparison of the type specimen of *Crinum roperensis* (right) with *Crinum uniflorum* F. Mueller (left).



Fig. 8. Maturing fruit of *Crinum roperensis*.



Fig. 9. Seeds of *Crinum roperensis*.

Habitat:

Reddish sandy soils among brush in open, relatively flat, sparsely wooded tropical Savannah.

DISCUSSION

The only Australian species described that approaches *Crinum roperensis* on morphological features is *Crinum uniflorum* F. Mueller. Pertinent differences include: *Crinum roperensis* is a significantly larger bulb; a photograph comparing the plant structure of *C. roperensis* with *C. uniflorum* is provided (Fig. 7). *Crinum uniflorum* has narrower leaves <0.5 cm wide, possesses leaves which lack denticulate margins, has leaves which are not clasped by their predecessors at the base (non-imbricate), and has leaves which do not form a rosette. Field photographs of *C. uniflorum* were previously published (Lehmiller, 2008). A further elaboration on the small *Crinum* species of Australia is planned in the near future.

The soil habitat differs markedly for each of these species with *C. uniflorum* growing in grassy-flat temporary pans in grey to light brown clay soils, while *C. roperensis* is found in red silty-sand soils and in a drier monsoon climate.

In cultivation, *C. roperensis* has grown well in a coarse sandy, well-drained potting mix with frequent watering during the growing season and provided with a full-sun exposure. It produces abundant seeds with cross pollination but few seeds with self pollination (Fig. 8-9). Several probable interspecific hybrids have been produced using it as a pollen donor.

This species was discovered along Roper Bar Highway near a tributary branch of Roper River. The name “Roper” possessed historical significance: John Roper was a member of the Leichhardt Expedition in 1844-1845. In the chronicles of this Australian expedition, Leichhardt (1846) commented that he had named Roper River in honor of John Roper, the latter’s name frequently appearing in the chronicles. Hence, it seemed appropriate that the specific epithet referenced both the man and the location.

ACKNOWLEDGEMENTS

IBS member Kristin Jakob of Valley Mills, California, is acknowledged for the botanical illustration of *Crinum roperensis*. IBS member John Lavranos contributed the Latin diagnosis.

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ADDENDUM NOTE

On the day preceding our discovery of *Crinum roperensis*, we had passed through Kakadu National Park. While within Kakadu, we partook of the opportunity to examine the ancient Aborigine artifacts at Nourlangie or Nourlangie Rock. These rocky formations, extending for about 1.5 km, were used as a shelter site by Aboriginal people intermittently during the period from 6,000 to 20,000 years ago; thereafter, the site became more popular as the local ecology changed and became more hospitable. This archeological site is known for containing the impressive Anbangbang Gallery of Aboriginal rock paintings.

The actual ages of many paintings remain uncertain as they were periodically repainted by special-talented individuals per time-honored Aboriginal traditions. The images often reflect legendary figures from the Dreamtime, an era when the Aboriginal people first came into being. The paintings depict particular stories from the past, and the interpretations of these stories are never revealed in significant details to non-aboriginals.

The painted characters in Fig. 10 are dancing, an important Aboriginal tradition. Aborigine men and women enjoy dancing.

The large, white male-like being illustrated in Fig. 11 is Namondjok, a dangerous spirit important from the creation time.

Top center in Fig. 12 is Namondjok. To his left, the slender, almost insect appearing entity is Namarrgon or “Lightening Man”; he is producing lightening (the curved circle) with special axes held in his hands. The white female figure below Namondjok is Barrginj, “Lightening Man’s” wife.

Photographs by the authors unless otherwise indicated.

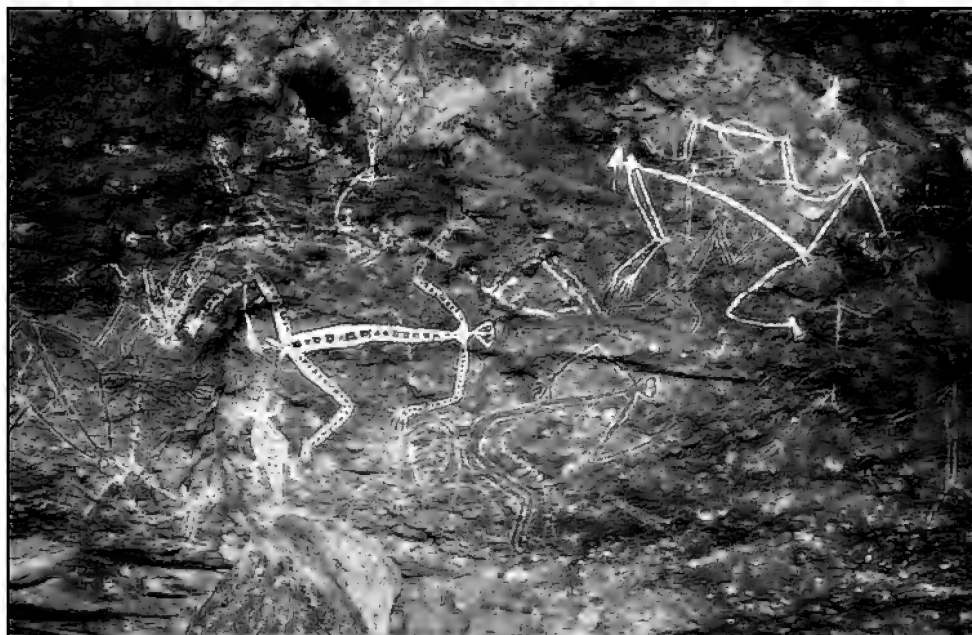


Fig. 10. The painted characters are dancing.

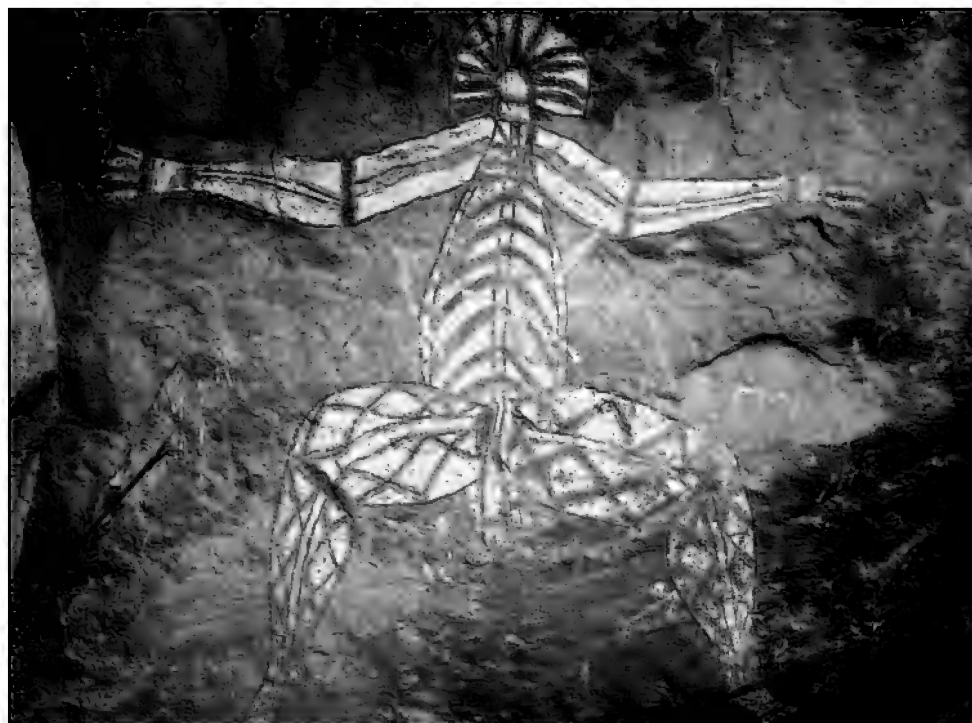


Fig. 11. Namondjok, a powerful spirit.



Fig. 12 In the upper center is Namondjok; to the latter's right is Namarrgon or "Lightening Man"; below and left of Namondjok is Barrginj, "Lightening Man's" wife.

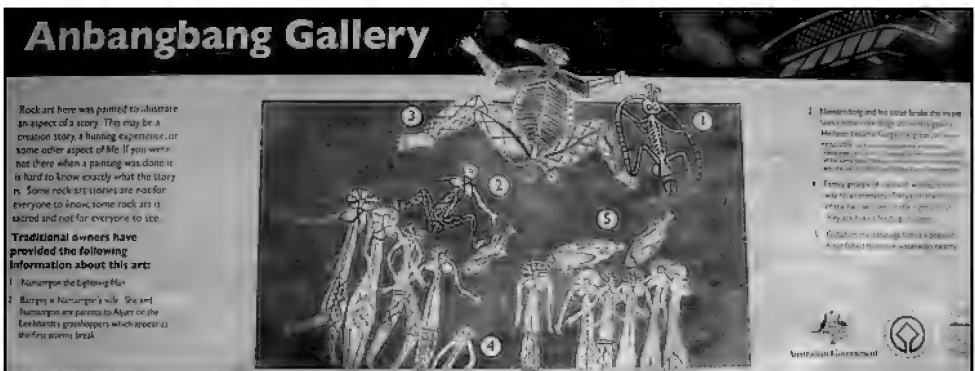


Fig. 13. Anbangbang Gallery interpretive sign of the rock painting in Figure 12.



Fig. 11. The authors admiring a colony of *Crinum flaccidum* adjacent to Mount Arthur, Wellington, Australia; left, Jim Lykos; right, Dave Lehmillier. Photograph by Robert Hamilton.

A NEW MEXICAN *ZEPHYRANTHES* (AMARYLLIDACEAE)

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ABSTRACT

Zephyranthes longituba Flory ex Flagg & G. Lom. Sm., **sp. nov.** is described and figures are included. This species has affinities with two other long-tubed species, *Z. chlorosolen* (Herb.) D. Dietrich and especially *Z. traubii* (Hayward) Moldenke, as both *Z. traubii* and *Z. longituba* have exerted stigmas and narrowly elliptic, reflexed perianth segments. However, *Z. longituba* possesses morphological characteristics which delimit it as a distinctive species. Its somatic chromosome number is given and compared to the numbers of *Z. traubii* and *Z. chlorosolen*.

INTRODUCTION

This taxon (Fig. 1) was first discovered by Mr. and Mrs. Morris Clint (Clint, 1957) in San Luis Potosi in April 1953 (*Clint M-292*). Mrs. Clint (1957) considered it a “white *Cooperia*” that “bears a large and beautiful flower and seems to be somewhere between *Z. traubii* and *Z. brazosensis*” [*Z. brazosensis* Traub = *Z. chlorosolen* (Herb.) D. Dietrich]. Dr. Walter S. Flory, Jr. on a collecting trip in July 1957 with Mr. and Mrs. Morris Clint in San Luis Potosi brought bulbs (*Flory 157*, *Flory 257*, and *Flory 557*) for study back to The Blandy Experimental Farm of the University of Virginia. We are publishing a name that Dr. Flory recognized as a new species (annotation Jun 1963), but did not publish.



Fig. 1. Photograph of *Zephyranthes chlorosolen* (on left) and *Z. longituba* (on right).

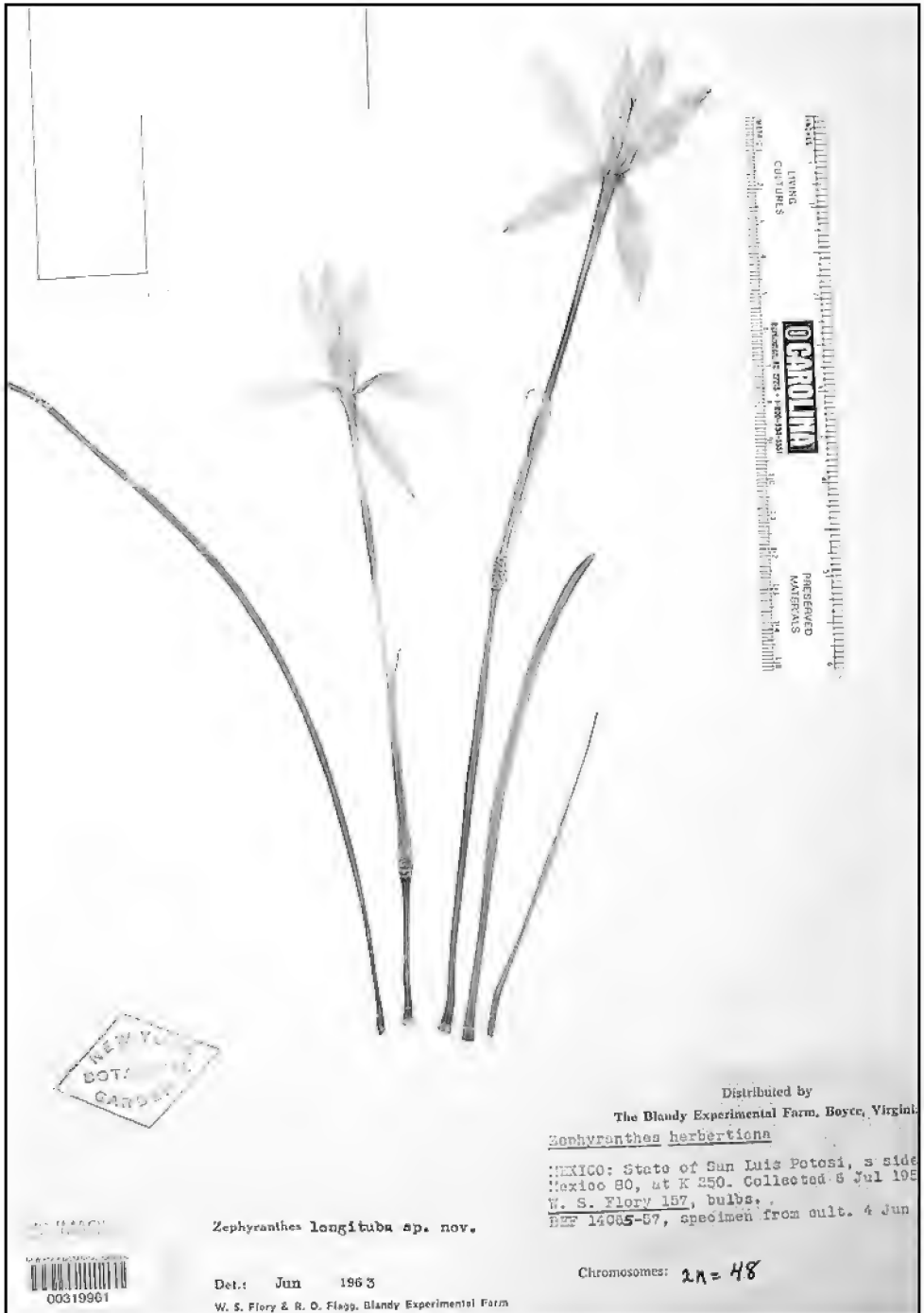


Fig. 2. Photograph of the holotype of *Zephyranthes longituba* (NY 319961).

Zephyranthes longituba Flory ex Flagg & G. Lom. Sm., **sp. nov.**

Basionym: *Zephyranthes longituba* Flory nom. nud.

Type: **Mexico**. San Luis Potosi: South side of Mexico 80 at K250, bulbs collected 6 Jul 1957, ex hort. 4 Jun 1962, *W.S. Flory* **157** (BEF 14065-57) (holotype NY!) (Fig. 2).

Paratypes: **Mexico**. Coahuila: Buena Vista, 1848-1849, *Dr. J. Gregg* **84** (MO!, NY!) [The collector's notations were more specific on location and date on the sheet at MO (Dry plains, Battlefield near Buena Vista, May 19, 1848) than on the sheet at NY (Buena Vista, 1848-49).]; 0.5 km N of Australia, Sierra de los Alamitos, alt. 1700 m, 13 Jun 92, *Chiang, Wendt & Johnston* **7750** (TEX, LL!); San Luis Potosi: E of Puerto de Lobos. ex hort. 31 Aug 1961, *Clint M* **-292** (BEF 15217-61) (US!); S side of Mexico 80 at K250, ex hort. 27 Aug 1962, *Flory* **257** (BEF 14054-57) (US!); Mexico 80 at K250, ex hort. 4 Jun 1962, *Flory* **557** (BEF 14057-57) (US!).

Description:

Latin diagnosis: Folia anguste linearia; spatha 4.2-6.3 cm longa; perianthium 14.8-18.7 cm longum hypocrateriforme album; tubus perianthii anguste cylindricus, ut minimum $\frac{3}{4}$ partes totius perianthii aequans; stigma breviter trifidum, ut minimum 3 mm ultra antheras exsertum; antherae erectae fasciculatae; $2n=48$. Vere aestateque floret.

Bulb ca. 2.5-3 cm tall, ca. 2.5 cm in diameter, neck ca 4-5 cm, tunic brown. **Leaf blade** dull green, narrowly linear to 1-3 mm wide. **Spathe** 4.2-6.5 cm long. **Flowers** erect; perianth white, salverform, 14.8-18.7 cm long; perianth tube primarily white, sometimes pale green proximally, 11.1-14.7 cm long, narrowly cylindric, at least $\frac{3}{4}$ of the total perianth, at least 15 times filament length, ca. 2-3 times spathe length; perianth segments 2.9-4 cm long, 8-14 mm wide, narrowly elliptic, reflexed; stamens fasciculate, appearing equal; filaments subulate, ca. 6-7 mm long, apex blunt; anthers erect, 5-9 mm long; stigma shortly trifid, exserted more than 3 mm beyond anthers; ovary sessile, 7-9 mm long, 3-4 mm wide; $2n=48$. Flowering in spring and summer.

DISCUSSION

Zephyranthes longituba has affinities with both *Z. traubii* (Hayward)

Moldenke and *Z. chlorosolen*. All three taxa are white-flowered with fasciculate anthers, and have a long cylindrical perianth tube at least $\frac{3}{4}$ of the perianth length and more than 1.5 times the spathe length. Both *Z. traubii* and *Z. longituba* have exerted stigmas and notably reflexed, narrowly elliptic perianth segments, but the stigma of *Z. chlorosolen* sits among the anthers and its broad perianth segments show little or no reflexing.

Characteristics that distinguish *Z. longifolia* from *Z. traubii* are broader leaves, longer spathes, usually longer perianths, and twice as many chromosomes. The spathe of *Z. longituba* exceeds 4 cm in length, and that of *Z. traubii* does not. The perianth of *Z. longifolia* usually exceeds 15 cm in length, and that of *Z. traubii* rarely does. *Zephyranthes longituba* appears very much like an enlarged form of *Z. traubii*. While *Z. traubii* and *Z. chlorosolen* thrive in full sun, *Z. longituba* grows best in partial shade, in keeping with its native habitat: “always in forested, moister locations” (Clint, 1959). It should be noted that J. Gregg referred to the habitat of his collection [Gregg 84 (MO)] as “Dry plains.”

The flowers of *Dr. J. Gregg* 84 were not easily analyzed. We included *Dr. J. Gregg* 84 as a specimen of *Z. longituba* because the senescent flowers were narrowly elongate lacking the broadness of *Z. chlorosolen* segments, the long spathes were suggestive of *Z. longituba*, and back-light examination indicated an exerted stigma.

Flagg (1961) recorded chromosome numbers for *Z. traubii* ($2n=24$, Fig. 3), *Flory* 157 ($2n=48$, Fig. 4), and *Z. chlorosolen* ($2n=48$, 60, 72, Fig. 5). The chromosome number of *Z. longituba* delimits it from *Z. traubii*. We originally considered that *Z. longituba*'s number might possibly represent an autopolyploid form of the number of *Z. traubii*. The morphology of *Z. longituba* would support this idea as its features are an enlarged form of *Z. traubii*, and both have exerted stigmas. However, a critical comparison of satellited chromosomes in each taxon suggests that an autopolyploid origin of *Z. longituba* is not the situation. Another possibility for the origin of *Z. longituba* involves hybridization between a *Z. chlorosolen* race of $2n=72$ and *Z. traubii*, which would yield *Z. longituba*'s reported number of $2n=48$. An examination of chromosome types suggests that *Z. longituba* shares chromosome types of both *Z. traubii* and *Z. chlorosolen*.

Hybridization in rain-lilies, followed by apomixis (Pace, 1913; Flory, 1939; Coe, 1953), is a mechanism for the establishment of new

species. Flagg and Flory (1976) documented through morphological and chromosomal analyses the hybrid origins of *Z. jonesii* (Cory) Traub, *Z. refugiensis* Jones and *Z. smallii* (Alex.) Traub in the Coastal Plain of Texas. Seed set in these taxa has long been considered to be primarily the result of apomixis, because of the high frequency of “maternals” when crosses have been attempted (Flory, 1939; personal observations). We feel that extensive hybridization (in several cases involving traditional *Zephyranthes* and traditional *Cooperia* species) has been a driving mechanism for much speciation in the Mexican rain-lilies. We treat *Zephyranthes* and *Cooperia* of Mexico and western U.S.A. as one genus because (1) they are part of a monophyletic clade (Meerow et al., 2000), (2) they lack genetic separation as evidenced by multiple instances of natural hybridization, and (3) they are phenotypically introgressive. We selected the name *Zephyranthes* because *Zephyranthes* Herbert (1821) has nomenclatural priority over *Cooperia* Herbert (1836).

Key to White, Long-tubed, Mexican *Zephyranthes* Species

- 1a. Stigma above the anthers.
 - 2a. Spathe 2-3.8 cm long, total perianth length usually less than 14 cm
.....*Z. traubii* (*Cooperia traubii*)
 - 2b. Spathe 4.2-6.5 cm long, total perianth length more than 14.5 cm
..... *Z. longituba*
- 1b. Stigma among or below the anthers.
 - 3a. Perianth salverform, ovary usually sessile, leaf not notably wider than scape
.....*Z. chlorosolen* (*C. drummondii*)
 - 3b. Perianth broadly funnellform, ovary pedicelate, leaf notably wider than scape
.....*Z. drummondii* (*C. pedunculata*)

ACKNOWLEDGEMENTS

We thank Barbara M. Thiers (NY), Carolyn Beans (GH), James Solomon (MO), Tom Wendt (TEX, LL), and George F. Russell (US) for making loans available. We are particularly indebted to Mark Garland (<http://botanicallatin.org>) for the Latin diagnosis.

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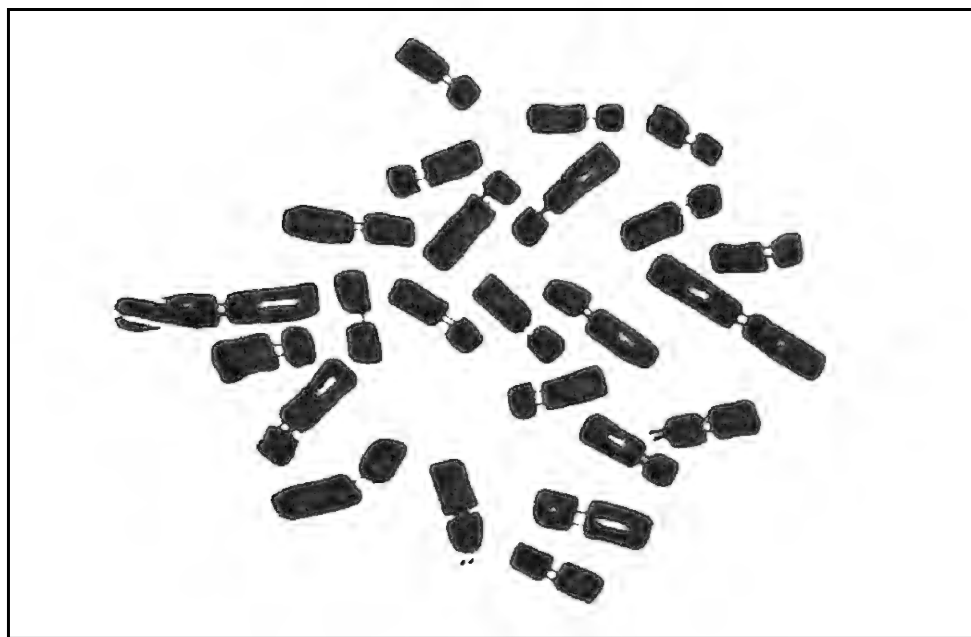


Fig. 3. Camera lucida drawing of somatic chromosomes of *Zephyranthes traubii* (BEF 15029-61, Flagg **T-47-T4**), $2n=24$ (Flagg, 1961).

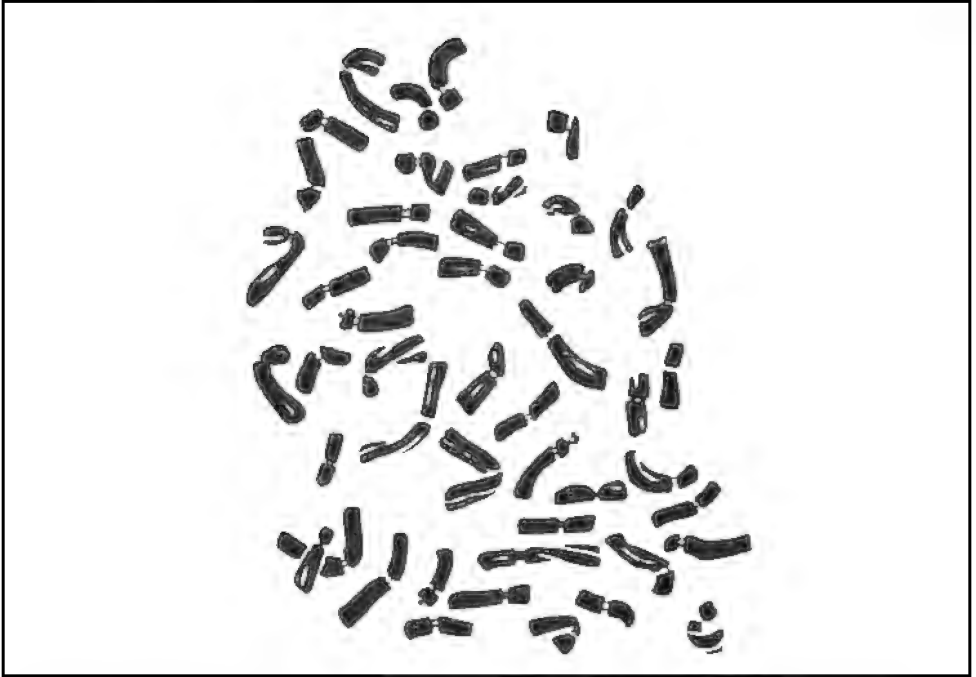


Fig. 4. Camera lucida drawing of somatic chromosomes of *Zephyranthes longituba* (BEF 14065-57, Flory 157), $2n=48$ (Flagg, 1961).

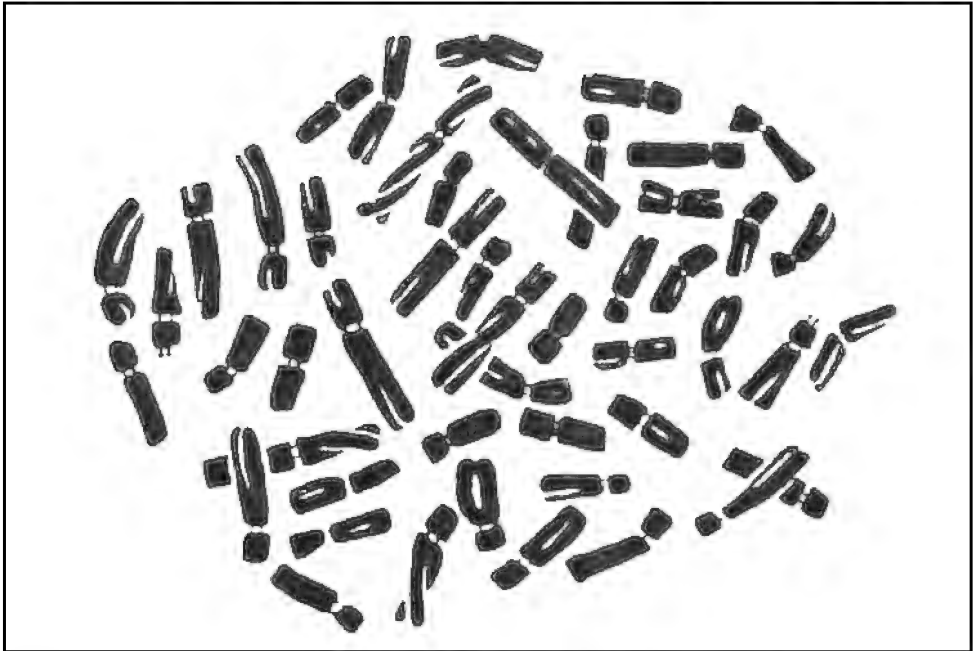


Fig. 5. Camera lucida drawing of somatic chromosomes of *Zephyranthes chlorosolen* (BEF 14445-59, B.F. Jones s.n.), $2n=48$ (Flagg, 1961).

***x*HOWARDARA, A NEW TRIGENERIC HYBRID (AMARYLLIDACEAE)**

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DNA sequencing studies performed by Meerow and colleagues (1998, 1999, 2000, 2010) demonstrated that close genetic relationships existed between *Sprekelia*, *Hippeastrum*, *Habranthus* and *Zephyranthes*. In agreement with these DNA studies were a number of reported bigeneric hybrids between the four genera, including: 1) between *Sprekelia* and *Habranthus* – *xSprekanthus* Traub (1969); 2) between *Sprekelia* and *Hippeastrum* – *xHippeastrelia* (?) Pradhan (1970); 3) between *Zephyranthes* and *Habranthus* – *xZephybranthus* Howard (1990); and 4) between *Sprekelia* and *Zephyranthes* – *xSprekelianthes* Lehmiller (2003-2004). If *Cooperia* was considered to be a separate genus from *Zephyranthes* rather than a subgenus, then several other bigeneric taxa existed (see Howard, 1990). In addition, Schulz (1954) briefly mentioned a cross she had made between *Hippeastrum* ♀ and *Zephyranthes* ♂, but she did not illustrate it nor provide any specific details nor suggest a taxonomic name for her intergeneric hybrid.

In the early spring of 2007 while attending a Greater Houston Amaryllis Club meeting, Mrs. Wilhelmina Prasek presented me with a flowering size bulb of a *xHippeastrelia* that she had made by pollinating *Sprekelia formosissima* (L.) Herbert ♀ with *Hippeastrum* ‘Hercules’ ♂. Within a short time, the bulb produced a scape bearing two lovely, dark red flowers (Fig. 1). As *Sprekelia howardii* Lehmiller (1999) (Fig. 2) was blooming simultaneously, a bulb from the type locality in Mexico, I made the cross:

xHippeastrelia ‘Wilhelmina Prasek’ ♀ x *Sprekelia howardii* ♂

Multiple viable seeds resulted from this cross, of which 11 seedlings survived the first summer and were transplanted into a larger pot; these seedlings represented a *xHippeastrelia* ‘Outcross’.

The *xHippeastrelia* ‘Outcross’ seedlings grew rapidly, and one bulb bloomed in early 2009 (Fig. 3). I attempted various crosses with its pollen, including *Hippeastrum*, *Zephyranthes*, and *xSprekelianthes*. One such cross



Fig. 1. *xHippeastrelia* 'Wilhelmina Prasek'.

with *Zephyranthes traubii* (Hayward) Moldenke (1951) (Fig. 4) resulted in seeds. Many years previously I had collected my bulbs of *Z. traubii* near the beach in Galveston, Texas, not many miles from Angleton, Texas, where Hayward's (1936) type specimen of "*Cooperia traubii*" had originated (Hayward's bulbs had been collected by Traub).

Zephyranthes traubii ♀ x *xHippeastrelia* 'Outcross' ♂

Only three seeds germinated and survived the summer. However, it was soon clear that these seedlings were hybrids because their leaves became wider and longer than *Z. traubii* and developed channeled contours. The seedlings grew until December 2009, at which time they were subjected to dry dormancy over winter within their clay pot until March 2010.

The three seedlings actively grew during the spring and summer of 2010, and quite unexpectedly, on 31 August 2010 one of the seedlings bloomed following a period of very heavy rainfall, approximately 16 months after germination of the seeds. The unique red flower, plus the associated leaves which were considerably larger than the seed parent, *Zephyranthes traubii* ♀, left no doubt that this was a trigenic hybrid between *Zephyranthes*, *Sprekelia*, and *Hippeastrum* (Fig. 5). I decided to



Fig. 2. *Sprekelia howardii* Lehmiller. Bulb originally collected south of Taxco, Mexico.



Fig. 3 *xHippeastrelia* 'Outcross'.



Fig. 4. *Zephyranthes traubii* (Hayward) Moldenke. Bulb originally collected in Galveston, Texas.



Fig. 5. Type bulb of *xHowardara* Lehmiller in flower, Lehmiller 1954 (TAMU).

introduce a new nothotaxon and prepared a herbarium specimen with this flower:

xHowardara* Lehmiller, *nothogen. nov.

Trigeneric hybrid between *Zephyranthes* Herbert, *Sprekelia* Heister, and *Hippeastrum* Herbert.

Type: *Zephyranthes traubii* ♀ x [(*Sprekelia formosissima* ♀ x *Hippeastrum* ‘Hercules’ ♂) ♀ x *Sprekelia howardii* ♂] ♂, ex. hort., 31 August 2010, Lehmiller 1954. (Holotype: TAMU) (Fig. 5, 9).

Soon a second surprise occurred. Following another episode of heavy rainfall, the original type bulb and a second bulb bloomed simultaneously on 25 September 2010 (Fig. 6). Although the leaves on the two bulbs appeared rather similar in morphology and arrangement, there was floral variability (Fig. 7, 8) as might be expected in a complex hybrid cross. The second bulb subsequently bloomed again on 18 November 2010.

DISCUSSION

One can appreciate the contribution from *Sprekelia* in the contour of the flower petals of *xHowardara*, but it has been considerably diluted. Actually, the floral pattern of the *xHowardara* type-bulb flower bears resemblance to *Zephyranthes*, while the flower of the second bulb is more suggestive of a miniature *xHippeastrelia*. In contrast, the type specimen for *xSprekelianthes* Lehmiller also utilized *Zephyranthes traubii* as the seed parent ♀, and here the contribution from *Sprekelia formosissima* ♂ dominated the floral pattern.

As mentioned previously, the two bulbs which have bloomed demonstrate variability in their flowers. The third bulb, the unbloomed one, has different appearing leaves than the other two, its leaves being narrower and darker green in color. So when the third bulb blooms, additional variability is anticipated in its flower.

No *xHowardara* bulbs have yet to produce an offset. An initial attempt at seed production by crossing the two flowers appearing in Fig. 6 did not yield seeds. A self pollination of the late flower of the second bulb in November 2010 resulted in three large deformed seeds which did not germinate. However, backcrossing of pollen from each blooming *xHowardara* bulb ♂ onto *Zephyranthes traubii* ♀ resulted in multiple seeds in each case, many of which germinated.



Fig. 6. *xHowardara* Lehmiller. The bulb selected as the type is the one on the left with the near-upright flower.



Fig. 7 *xHowardara* Lehmiller. Close up of the flower of the type bulb in Fig. 6.

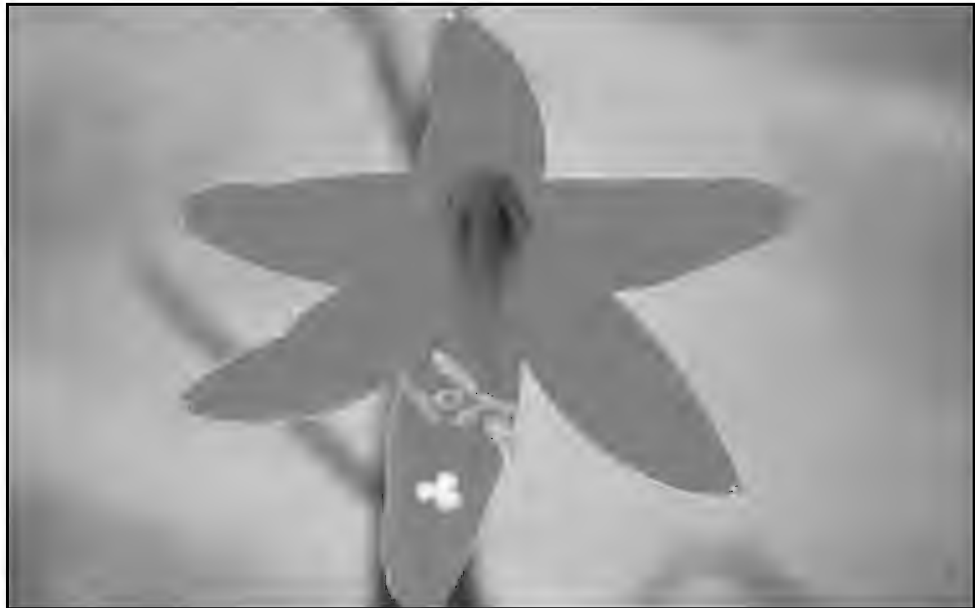


Fig. 8. *xHowardara* Lehmiller. Close up of the flower of the second bulb in Fig. 6.

This trigeneric hybrid is named in honor of the late Dr. Thaddeus (Thad) Howard, former Herbert Medalist, renown collector of bulbous plants of Mexico, pioneer in developing complex interspecific *Crinum* hybrids, long time member of the International Bulb Society (>50 years), frequent contributor to *Herbertia*, and close personal friend.

ADDITIONAL NOTES

The bulb of *xHippeastrelia* ‘Outcross’ (Fig. 3) utilized in making this trigeneric hybrid subsequently bloomed multiple times, although it has remained seed sterile to date. A second bulb of this cross bloomed in early 2010; this latter bulb differed by having a longer and larger diameter scape bearing a flower closer to *Sprekelia formosissima* in appearance, and it proved to be seed fertile (see below). For unknown reasons, the remaining nine bulbs of this cross have yet to flower.

The above second bulb of *xHippeastrelia* ‘Outcross’ ♀ was pollinated by another unusual intergeneric outcross, [*xSprekelianthes* ♀ x *Sprekelia howardii* ♂] ♂, resulting in multiple deformed seeds. One seed germinated though, and at the time of this writing the resultant seedling has developed four shiny green leaves. Should it prove to be a true hybrid, it will represent another form of *xHowardara*.

In late 2010, the cross *Zephyranthes traubii* ♀ x *xHippeastrelia* ‘Wilhelmina Prasek’ ♂ was accomplished on two different occasions. In the first instance, multiple seeds resulted but only one seed germinated, the latter at the time of this writing being a tiny seedling with 3 leaves. The second instance yielded only three seeds, but all three germinated. Should these prove to be true hybrids, these will be an additional variation of *xHowardara*.

All photographs by the author.

ACKNOWLEDGEMENTS

Mrs. Wilhelmina Prasek is appreciated for providing me with a flowering size bulb of the *xHippeastrelia* which she had made; her son, Charles Prasek, President of the Greater Houston Amaryllis Club, had recommended to her that she share her treasure with me.

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Fig. 9. Type specimen, *xHowardara* Lehmilli, Lehmilli 1954 (TAMU).

THE GENUS *CRYPTOSTEPHANUS* WELW. EX BAKER

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INTRODUCTION

Amongst sub-Saharan Africa's treasure trove of amaryllids, *Cryptostephanus* is noted more for its curiosity value than for its ornamental attributes by bulb enthusiasts. It comprises three disjunct species, *C. densiflorus* Welw. ex Baker from southwestern Angola and northwestern Namibia, *C. haemanthoides* Pax, native to Kenya and Tanzania in Tropical East Africa, and *C. vansonii* Verd. from eastern Zimbabwe and western Mozambique in southern Tropical Africa (Verdoorn 1943; Duncan 2002, 2008). Its most well known member and the only species cultivated to any extent is *C. vansonii*, an evergreen plant with a flat-topped inflorescence of numerous pure white to light pink tubular flowers with spreading to suberect tepals, followed by globose, bright pinkish red fleshy berries. *Cryptostephanus haemanthoides* and *C. densiflorus* are poorly known, the latter species in particular, discovered by the Austrian medic, explorer and botanist, Friedrich M.J. Welwitsch (1806–1872).

Friedrich Welwitsch began work for the Portuguese government in 1839 and spent a seven-year period from 1853 to 1861 collecting plants and animals in its southwest African colony, Angola. He brought back more than 8000 plant specimens, of which about 1000 were new to science, and represented the single most important collection ever made in Tropical Africa, eventually distributed to more than twenty herbaria, and was the subject of a published catalogue produced in two lengthy volumes (Hiern 1896; Rendle 1899). On 3rd September 1859, Welwitsch said of the 'wonder plant' that bears his name, *Welwitschia mirabilis* Hook.f. that he discovered near Cabo Negro in the Namib Desert in the extreme south-western corner of Angola: "I am convinced that what I have seen is the most beautiful and majestic that tropical South Africa can offer". By sharp contrast, Charles Darwin described it as the 'platypus' of the Plant Kingdom (vegetable

Ornithorhyncus), and J.D. Hooker, the Director of Kew who formally described it, thought it the most interesting, albeit the ugliest plant ever brought into Great Britain (Bornman 1978).

Welwitsch made the first collection of *Cryptostephanus densiflorus*, the type species of a new genus, in January 1860. He found it in bushy places in sandy soil near Lopolla, in the mountains of Huíla Province in the temperate south-western region of Angola, at altitudes between 1321–1500 m. The generic name *Cryptostephanus* is derived from *crypto* (hidden), and *stephanus* (a crown), and is descriptive of the partially hidden, crown-like structure of free, linear appendages attached to the inner apex of the perianth tube, known as a corona; the specific name *densiflorus* refers to the dense arrangement of flowers in the inflorescence. Welwitsch made descriptive notes from his living specimens, and the pressed material was deposited at the British Museum (Natural History), where it lay unpublished until seen by J.G. Baker of Kew during the course of his examination of various new amaryllids collected during the Welwitsch and Schweinfurth expeditions to Angola and Central Africa, respectively. Baker validated Welwitsch's description in the *Journal of Botany* (New Series), stating: "This is certainly the most interesting new plant amongst all the hundred and twenty new bulbs which Dr Welwitsch discovered in his Angolan expedition" (Baker 1878). Accompanying the description is a superb pencil drawing by D. Blair (t. 197) of a whole plant in flower, a dissection of a flower and an unripe infructescence.

Since Welwitsch's discovery, *C. densiflorus* has been found to extend to the north-western part of Namibia, and is the only member of the genus recorded for the southern African subregion. The specimen illustrated here was collected in 2005 by my colleague Ernst van Jaarsveld in the Kaokoland Centre of Endemism, in the far north-western corner of Namibia, where it was found growing between a rock crack in dappled shade. I cultivated it in the Bulb Nursery at Kirstenbosch where it flowered for the first time in early February 2008 and again in late January and early February 2009, and it was painted by Vicki Thomas for *Curtis's Botanical Magazine* from the latter flowering. To the best of my knowledge these are the first flowerings in cultivation and the painting is the first colour rendition of the species to be published (Duncan 2010).

Morphologically poorly known until recently, *Cryptostephanus densiflorus* (Fig. 1, 2) is readily identified by its usually dense inflorescence

of spreading to pendulous, distinctly curved, tubular, purplish maroon flowers with recurved tepal apices, with the anthers and style well included within the tube. The intensely glaucous leaves are slightly canaliculate and the clasping bases of the lowermost leaves have attractive purplish marbling. The inflorescence is contemporary with the leaves, emerging from the centre of the plant between the youngest leaves, and the strongly compressed scape elongates rapidly to a length of up to 370 mm, but remains considerably shorter than the longest leaves when fully extended. The flowers are unscented, contain small amounts of nectar in their inflated bases and are remarkably short-lived, barely lasting three days before dropping off, the flowering period of the whole inflorescence lasting no more than about ten days. Whereas the flowers of *C. vansonii* are at least partially self fertile, those of *C. densiflorus* appear to be self sterile. The short, erect, subterranean rhizome produces numerous thick, perennial fleshy roots; the plant does not produce offsets, and is distinctly summer-growing with a pronounced winter dormant period. The species occurs as scattered individuals over a wide area in lightly shaded woodland or in open thickets in full sun, often in rocky terrain. Welwitsch noted that flowering took place in October and November and ripe fruits were borne in January at the type locality in south-western Angola (Baker 1878), whereas the plant being cultivated at Kirstenbosch from northwestern Namibia was seen in flower in February and consistently flowers in January and February.

Cryptostephanus haemanthoides (Fig. 3), the second species to be described, was discovered by J.M. Hildebrandt in February 1877 in the Taita Hills southeast of Tsavo National Park in southern Kenya, and was described many years later in Volume 15 of Engler's *Botanische Jahrbucher* (Pax 1893). Its distribution extends south to Tanzania where it is widespread, growing in open aspects in full sun, as well between granite rocks or occasionally as a lithophyte in deep shade of evergreen woodland. The plant was beautifully illustrated by Margaret Stones on Plate 772 of *Curtis's Botanical Magazine* and accompanied a comprehensive account of the species (Cribb, 1979).

The leaves of forms of *C. haemanthoides* growing in exposed positions are rather similar to those of *C. densiflorus* in being erect to suberect, canaliculate and intensely glaucous with slightly spirally twisted apices, whereas those from shaded environments are spreading, almost flat



Fig. 1. Bud stage of *Cryptostephanus densiflorus* from northwestern Namibia, cultivated in the Kirstenbosch Bulb Nursery. Photograph by Graham Duncan.



Fig. 2. *Cryptostephanus densiflorus* from northwestern Namibia, cultivated in the Kirstenbosch Bulb Nursery. Photograph by Graham Duncan.



Fig. 3 *Cryptostephanus haemanthoides* in cultivation. Photograph courtesy of John Ingram.

and dark green. Its fleshy roots differ from the other two species in being tuberous in the lower part. The flowers of *C. haemanthoides* differ markedly from those of *C. densiflorus* in their much longer, narrower, straight perianth tubes that are more or less double the length, in its stamens and style that are exserted beyond the perianth tube, and in its distinctly spherical inflorescence containing many more flowers (up to 100). Whereas perianth tube and tepal colour in *C. densiflorus* is purplish maroon, in *C. haemanthoides* it tends more towards maroonish brown. As with *C. densiflorus*, *C. haemanthoides* is a deciduous, summer-growing plant, flowering in summer after the leaves have fully developed, and undergoing a distinct winter dormant phase.

Exactly half a century subsequent to the publication of *C. haemanthoides*, the South African botanist Dr Inez Verdoorn described *Cryptostephanus vansonii* (Fig. 4, 5) in the text accompanying Plate 885 of *The Flowering Plants of South Africa* (Verdoorn 1943). The plant had been collected in Zimbabwe by the Russian naturalist Georges van Son who later settled in South Africa; he flowered it in his garden near Pretoria and it was illustrated by Edith Burges. The species is endemic to the eastern highlands of Zimbabwe in the forests of the Vumba and the southern Chimanimani



Fig. 4. *Cryptostephanus vansonii* from eastern Zimbabwe, cultivated in the Kirstenbosch Bulb Nursery. Photograph by Graham Duncan.



Fig. 5. Ripe berries of *Cryptostephanus vansonii*, from plants cultivated in the Kirstenbosch Bulb Nursery. Photograph by Graham Duncan.

Mountains, and the adjacent forests of western Mozambique (Verdoorn 1943; Zimudzi *et al.* 2006). Growing amongst rocks in deep shade, its white fleshy roots are covered with a corky velamen layer and spread out horizontally within leaf litter of the forest floor. Whereas *C. vansonii* is unmistakable in its white to light pink flowers with spreading to suberect tepals and clump-forming habit, it is the other two species with their similar perianth colour that are superficially easily confused, but are very distinct when examined closely.

Cryptostephanus has a rhizomatous rootstock with perennial fleshy roots, two rows of strap-shaped evergreen or deciduous leaves produced from a short to long, erect pseudostem, a laterally compressed scape bearing a pseudo-umbel of numerous tubular, spreading to pendent flowers, filaments that are adnate to the tube for most of their length, a capitate stigma and globose fleshy fruits producing rounded fleshy seeds with a phytomelanous testa. It is unique within the family Amaryllidaceae in the presence of a hidden corona that is distinctly exterior to the stamen whorl. *Cryptostephanus* is morphologically similar to that of *Clivia*, the latter a genus of six species endemic to the southern African countries of South Africa and Swaziland. *Clivia* has a similar rhizomatous rootstock with perennial fleshy roots, strap-shaped leaves produced in opposite ranks from a pseudostem, a laterally flattened scape, a many-flowered inflorescence with spathe bracts and bracteoles, and mainly tubular perianths with fleshy fruits and seeds (Duncan 2008). Like those of *Clivia*, the scapes of *Cryptostephanus* exude plentiful sticky sap when cut.

Apart from differences in tepal colour and dimension, *Clivia* perianths differ primarily in the absence of a corona and the absence of phytomelanin in its seed coats, as well as in having its filaments free to the base and in having a branched stigma. The taxonomic position of *Cryptostephanus* has given rise to considerable debate. Baker (1878) considered it most closely related to *Narcissus* L. on account of the staminodia (segments of the corona) that he described as ‘palpably representing an outer whorl of stamens’ due to the presence of a small abortive anther at their tips, a view followed by Bentham and Hooker (1883) who placed the two genera together in their subtribe Coronate. Baker also considered the habit and floral structure of the plant as close to *Tulbaghia* L., but noted the very different capsular fruit of the latter (Baker 1878).

Cryptostephanus has been allocated to various tribes and subtribes by

numerous authors, but the first to formally recognise the close affinity between it and *Clivia* was Hamilton P. Traub, who placed both genera as the only members of his tribe Clivieae Traub (Traub 1963). Two classifications of the African Amaryllidaceae (Müller-Doblies and Müller-Doblies 1996; Meerow and Snijman 1998) both recognised two tribes for the fleshy-fruited genera, Haemantheae (*Haemanthus*, *Scadoxus*, *Clivia* and *Cryptostephanus*) and Gethyllideae (*Gethyllis* and *Apodolirion*). As a consequence of a molecular study of the tribe Haemantheae, all six genera now form part of the tribe Haemantheae, and the close relationship between *Cryptostephanus* and *Clivia* has been shown, in which these two monophyletic rhizomatous genera comprise one of the main resolved clades (Meerow and Clayton 2004). In a more recent study it has been estimated that the Haemantheae started to diverge in the early Oligocene (28 Ma) and that *Clivia* split from *Cryptostephanus* in the late Oligocene (25 Ma) (Conrad 2008).

Chromosome number in *Cryptostephanus* was first measured by J.B. Gouws in *C. vansonii* and gave $x = 12$ (Gouws 1949); while both *C. densiflorus* and *C. haemanthoides* are assumed to have the same basic number, neither have actually yet been measured. Gouws was also the first to measure chromosome number in *Clivia*, for which he obtained the basic number $x = 11$, and drew attention to the similar karyotypes of the two genera (Gouws 1949).

KEY TO THE SPECIES OF *CRYPTOSTEPHANUS*

- 1a. Plants evergreen, clump-forming, leaves dark green, arcuate, perianth white to light pink, tepals spreading to suberect, eastern Zimbabwe and western Mozambique *C. vansonii*
- 1b. Plants deciduous, solitary, leaves glaucous, spreading to suberect or erect, perianth purplish maroon, tepals recurved
..... 2
- 2a. Perianth tube straight, 20 mm long, stamens and style exserted beyond perianth tube, southern Kenya, widespread in Tanzania
..... *C. haemanthoides*
- 2b. Perianth tube curved, 8–12 mm long, stamens and style included within perianth tube, south-western Angola to north-western Namibia
..... *C. densiflorus*

The narrowly funnel-shaped perianth tube of *Cryptostephanus* is similar to that of certain species of *Cyrtanthus*; one member of the latter genus, the evergreen plant now known as *Cyrtanthus herrei* F.M.Leight. was first described as a doubtful species of *Cryptostephanus*, as *C. ? herrei* F.M.Leight. in the periodical *South African Gardening and Country Life* (Leighton 1932). It is endemic to the Richtersveld in the far north-western corner of South Africa's Northern Cape Province, and has a large ovoid bulb with a long aerial neck, broad, spirally twisted glaucous leaves, and very long pendulous, reddish-orange tubular flowers with greenish tepals. It was placed in *Cryptostephanus* on account of the presence of lateral lobes at the base of its filaments that were mistakenly interpreted as a corona, a key character in *Cryptostephanus*, but in reality were merely expanded filament bases, forming a false corona (Leighton 1932). It was later discovered that the fruit of *Cryptostephanus ? herrei* differed markedly from that of other species of this genus in being an elongate capsule producing papery, winged black seeds, instead of globose berries containing water-rich seeds typical of *Cryptostephanus*, and the taxon was subsequently transferred to *Cyrtanthus* (Dyer 1959). Similarly, the plant collected by E. Rusch in the Richtersveld in 1934 and described as *Cryptostephanus merenskyanus* Dinter & G.M.Schulze (Schulze 1941), is synonymous with *Cyrtanthus herrei*.

CULTIVATION

The evergreen *C. vansonii* is certainly the most easily cultivated member of the genus (Bennett, 1980; Duncan, 2002). It likes conditions similar to those preferred by the five *Clivia* species from the summer-rainfall parts of South Africa (*C. caulescens*, *C. gardenii*, *C. miniata*, *C. nobilis* and *C. robusta*), but with less moisture, as its roots are more sensitive to rotting in insufficiently well drained media. It performs very well in light to deep shade in slightly acid leaf mould, or a mixture of composted bark and coarse grit. In ideal conditions it is a long-lived plant and forms offsets, although not as rapidly as in most *Clivia* species, flowering reliably and often producing two flushes of blooms per year, in spring and again in autumn (Duncan 2000). The plant is ideally suited to containers and also does well outdoors in mild climates, such as in the southern suburbs of Cape Town, provided it has sufficient shade and excellent drainage.

Although *C. haemanthoides* has recently been introduced into specialist

bulb collections, it would seem that a lot has yet to be learned regarding its successful cultivation. The most commonly encountered problem appears to be rotting of the rhizome and fleshy roots due to over-watering in summer, and their desiccation due to excessive drought during the winter months. However, at least one person has managed to cultivate the plant successfully, as seen in the accompanying photograph by John Ingram (Fig. 3). Depending on the origin of the form being grown, *C. haemanthoides* can be placed in lightly shaded or sunny positions, and will probably do well in a slightly acid medium of composted bark mixed with coarse grit.

Cryptostephanus densiflorus performs fairly well in containers in a frost-free environment, in a sharply drained medium consisting of grit and coarse sand mixed in equal proportion, with a layer of well rotted compost placed at the base of the container. At Kirstenbosch it has been successfully grown in a 25 cm diam. container, with the top of the rhizome resting just below soil level. The rootstock is extremely sensitive to over-watering. At the beginning of the growing season in early summer, an initial drench is applied, and then not again until the leaf shoots appear within two to three weeks, following which a weekly drench is given. Towards the end of summer the leaves begin to turn yellowish brown, and this is the cue to gradually decrease drenching to once fortnightly, and finally to withhold moisture altogether once the leaves have almost fully desiccated. The rootstock should not be lifted and stored bare-rooted over the dormant period but be left in its dry medium until the onset of new growth in early summer (Duncan 2010).

The leaf upper surfaces are highly susceptible to infestation by red spider mites within warm, enclosed, greenhouse conditions, and ideally the plants should be placed in a well ventilated spot where they receive maximum light. The seeds of *Cryptostephanus vansonii* are notorious for slow germination when sown conventionally and are best allowed to remain within the ripe fruits and germinate while still attached to the ovary wall, then be removed and potted-up individually; presumably this method should be followed with *C. haemanthoides* and *C. densiflorus*. The juvenile period for *C. vansonii* is four years in ideal conditions, but is unknown in *C. densiflorus* and *C. haemanthoides* as seeds have not yet become available with which to experiment. Once established, *C. densiflorus* (and the other two species) should be left undisturbed for many years, with occasional re-potting, and careful attention paid to moisture

application and outbreaks of red spider mites, and perhaps mealy bugs that would certainly find the rhizome tunic bases an ideal area for infestation.

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A SYNOPSIS OF PERENNIAL TUBEROUS *TROPAEOLUM* L. SECTION *CHILENSIA* SPARRE (*TROPAEOLACEAE*), INCLUDING VALIDATION OF THREE SUBSECTIONS AND A NEW, RECLASSIFIED NATURAL HYBRID

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ABSTRACT

Tropaeolum, the sole genus in the family Tropaeolaceae, comprises two sections. Sect. *Tropaeolum* is largely tropical and annual. Sect. *Chilensia* Sparre, as profiled below, is predominantly temperate and of tuberous perennial life-form. The latter contains five subsections, three of which are published validly for the first time here. Salient distinctions of all subsections and taxa in sect. *Chilensia* are outlined, and keys and further facts provided, including additional taxonomic, ecological, conservational and horticultural information. The morphological boundaries of former *T. jilesii* Sparre are expanded and its classification is altered to nothospecies, with *T. looseri* Sparre and *T. sessilifolium* Poepp. & Endl. the postulated parental species. As a result its nomenclature and authorship are changed to *Tropaeolum* x *jilesii* Sparre, emend. J.M. Watson & A.R. Flores. Reasons for this reclassification are discussed.

PREFACE

The present authors recently broadly overviewed sect. *Chilensia* of *Tropaeolum*, including initial presentation of five new subsections (Watson & Flores, 2010a). This was based on almost four decades of intermittent observation in the field and periods of more focussed study over the last two decades. That overview compliments and forms the basis for the following, more detailed synopsis. However, in order to avoid undue duplication we have summarised or omitted specific details and conclusions discussed in our earlier work which are not relevant here, even though they may be of importance in the context of the section. As an instance, of the surmised evolutionary history of the family and genus and its consequent phytogeography, only the reason for differing spur lengths in one subsection is analysed below for the first time.

INTRODUCTION

The genus *Tropaeolum* was recently reclassified as monotypic by Andersson & Andersson (2000), equating it with the family Tropaeolaceae. It currently contains 94 species and a further 12 subspecies and varieties. Those figures include three taxa of two recently incorporated genera, *Trophaeastrum* Sparre, and *Magellana* Cav. Of that total, 23 species plus 4 subspecies are attributed to sect. *Chilensia* (Sparre & Andersson, 1991, Berry, 1992, Andersson & Andersson, 2000, Watson & Flores, 2010a, Garralla & Bulacio, 2010, E. Bulacio, in litt.,).

Descriptions and other amplified data above sectional level are not provided here as these may be found in monographs of the group (e.g., Sparre & Andersson, 1991), general systematic works (e.g., Jury, 1978) and relevant floras (e.g., Pérez-Moreau & Crespo, 1988). Furthermore, detailed analysis of sect. *Tropaeolum* is limited to nothing more than differentiating it from sect. *Chilensia*.

Due to an unfortunate oversight, full details of corresponding basionyms were not provided for three of our new sect. *Chilensia* subsections, subsects *Chymocarpus*, *Magellana* & *Trophaeastrum* (Watson & Flores, 2010a), as is required by ICBN Article 33.3 (McNeill et al., 2006). As a consequence they were invalid, which has necessitated legitimate publication below.

Full morphological data and metric dimensions may also be found in standard Tropaeolaceae monographs, or in protologues of the taxa featured below, and so are not repeated here. Descriptive details are limited to salient features which distinguish each taxon from all others and enable it to be identified readily. The only exceptions will be found when greater taxonomic clarification is required for any reason.

Entries under the category ‘Habitat and Ecology’ list the number of broad habitat types for each taxon over its full distribution. These discrete categories are derived from the system of Rodolfo Gajardo (1994) as applied to Chile and explained in greater detail in the following section. However, as noted there, we have also attempted rough equivalents for taxa occurring partially or entirely outside Chile.

In their standard monograph Sparre and Andersson (1991) provided keys for the main elements of the family Tropaeolaceae as then understood, i.e. the genera, the species, and all infraspecific taxa.

Along with Sparre’s earlier recognition of previously published infraspecific taxa of *Tropaeolum polyphyllum* Cav. as species (Sparre,

1955), inter alia, their work still forms an invaluable foundation, but it has since become outdated as a result of various subsequent developments, in particular for sect. *Chilensia*. Foremost among these are the DNA phylogenetic analyses of Andersson and Andersson (2000), Hernández-Pellicer (2003) and Hershkovitz et al. (2006). Results obtained by the Anderssons indicated the need for a drastic systematic revision, as noted above. In addition, new taxa have been described meanwhile, or are in press at the time of writing (Berry, 1992, Watson & Flores, 2000, Garralla & Bulacio, 2010, E. Bulacio, in litt.), and sect. *Chilensia* is now divided into subsections (Watson & Flores, 2010a). Further developments include the determination of several more natural hybrids (Hernández-Pellicer, 2003), Flores & Watson, ined.), the reestablishment of *Tropaeolum nubigenum* Phil. (Hoffmann et al., 1998), the elevation to full species of *Tropaeolum austropurpureum* (J.M. Watson & A.R. Flores) J.M. Watson & A.R. Flores (Watson & Flores, 2010b), and the reassessment here of former species *T. jilesii* as a nothospecies.

We detected certain errors or oversights in the morphological descriptions of Sparre and Andersson (1991). These affected the accuracy of their keys, inter alia, and required correction. In addition to our own observations, we also augmented morphological data from the Tropaeolaceae treatment in *Flora Patagonica* (Pérez-Moreau & Crespo, 1988). A further omission in their monograph was the absence of certain important common knowledge concerning the popular history or cultivation of tropaeolums. This undoubtedly mainly arose as a result of their personal lack of familiarity and experience with the relevant horticultural background.

Addition of new taxa, as well as necessary amplification and modification of some morphological characters, necessitated considerable re-writing and re-ordering for our key to sect. *Chilensia* compared with the equivalent coverage in Sparre and Andersson (1991). Some distinguishing features employed by them proved to be either inaccurate or lacking discontinuity and required being replaced by others.

The aspect of both natural and artificial hybrids is of considerable and significant systematic importance as well as undoubted horticultural interest. A number of new discoveries and developments await description and discussion. However, it is more appropriate to devote a separate account to this subject rather than further extending the present contents.

HABITAT AND ECOLOGY (see Appendix A)

Our sect. *Chilensia* overview (Watson & Flores, 2010a) includes a broad explanatory outline of the wide range of climatic and vegetational niches occupied by its taxa. Repetition of this aspect cannot be avoided here since it is intrinsic to an intelligible understanding. In fact it assumes even greater importance in the context of profiling individual taxa, necessitating a more detailed exposition.

The classification system for the natural vegetation of Chile created and published by Gajardo (1994) forms our basic source of reference. This is arranged as a descending and ever more detailed hierarchy of categories identified by predominant vegetation types. Inevitably in reality, a seamless overlap exists in almost all categories of course. The system begins with division of the country into eight major phytogeographical regions arranged approximately north to south and coded numerically:

1. Northern Desert
2. High Andean Steppe
3. Maquis and Xerophyll Scrub & Woods
4. Deciduous Woodland
5. Broad-leaf Evergreen Woodland
6. Andino-Patagonian Woodland
7. Evergreen Woodland & Wetlands
8. Patagonian Steppe

Tropaeolums are found in all eight regions.

Each region is then broken down into between two and four subregions which are letter-coded. For example, the first entry for the north is 1.A. the Arid Desert subregion. 1.D., somewhat further south, is the Flowering Desert subregion, while at the opposite end of the country 7.C. signifies the Bog, Wetland Scrub, and Marshy Steppe subregion. There are 21 subregions, 14 of which contain tropaeolums.

In the subsequent more localised breakdown, each subregion is partitioned into one to seven numbered vegetational super-communities or sectors. As further random illustrations, 1.A.3. covers the Desert Salt Pans and Pampas, 1.D.17 the Flowering Desert of Interior Upland Terrain, and 7.C.13 the Bogs & Swamp Steppe of the Magellanic Archipelago. These super-communities total 85, of which 37 are host to *Tropaeolum*. We have featured them in this work to illustrate the wide variation of plant communities inhabited by *Tropaeolum* taxa described here. It should be

appreciated that these definitions are very broad. ‘Deciduous Woodland’ does not imply an area totally covered in such habitat, but indicates deciduous woodland as the salient vegetation type chosen to label the area concerned. ‘Pacific Coastal’ not only implies the immediate littoral, but also a significant extent of maritime climatic influence somewhat inland.

The final and most detailed analysis is presented as numbered sets of more localised plant communities, identified by one or two of their dominants. A basic selection of species typically found in each of these communities is listed under the sub-headings ‘Accompanying’, ‘Common’ and ‘Occasional’. To give a working idea and to illustrate the full north-south habitat range of *Tropaeolum* in Chile, it extends from – 1.C.13.1 Northern Desert region; Pacific Coastal sub-region; Tocopilla sector; *Eulichnia iquiquensis*-*Frankenia chilensis* community for *T. beuthii* Klotzsch – to – 7.B.6.1 Evergreen Woodland & Wetland region; Small-leaved Woodland sub-region; Upland sector; *Nothofagus betuloides*-*Laurelia philippiana* community for *Tropaeolum speciosum* Poepp. & Endl. These local communities with specifically identified floral contents run into several hundreds, and identifying and numbering all those with tropaeolums present is a task beyond our capacity and certainly exceeding the scope of this work!

However, that a genus of a mere 21 native species in Chile from a national flora total in excess of 5200 species can be found in close to half the country’s major plant communities is surely an impressive enough statistic.

Gajardo’s system also serves as a useful indication of the adaptability and broad environmental success of taxa on the one hand, or alternatively their rarity, possible limiting specialisation, and vulnerability. Of all the taxa of sect. *Chilensia*, *Tropaeolum tricolor* Sw., a species principally adapted to hummingbird pollination, is outstanding. Not only is it the most common and widespread species, but it easily exceeds any other in its known adaptation to no fewer than 21 of Gajardo’s habitat types. This contrasts markedly with several taxa only recorded from one super-habitat type each.

Sect. *Chilensia* probably occupies at least a further dozen or more equivalent ecological niches beyond the national boundary of Chile – in Argentina, Bolivia, Brazil, Paraguay and Uruguay. It is not, of course, possible to ‘instantly’ equate these habitats with the Gajardo system, and our interpretation of them is relatively more simplified and all-embracing.

For each subsection and taxon, the following vegetational subregions

in which it is known will be found set out numerically in the ‘*Habitat and ecology*’ subheading.

Enumerated main vegetational subregions

In the list below, the initial code G signifies the system of ‘La Vegetación Natural de Chile’ (Gajardo, 1994). His categories were published in Spanish. We have taken the liberty of translating them freely for the benefit of English readers not familiar with the Chilean landscape and its defining ecological terms.

It should be understood that the flowering desert (G04-G08) is an extremely erratic event. It depends on global climatic cycles for a wide-scale manifestation, notably the Southern Oscillation or El Niño, which may only occur at intervals of a decade or more. Landscapes may appear totally sterile or moribund inbetween, with only larger cactus plants visibly alive. Most floras persist dormant as seed banks, geophytes and woody growth in suspended animation. Limited regional floration provoked by a combination of heavy localised precipitation and regular dense Pacific sea fogs is equally fitful, but more frequent in some. To a lesser extent this situation applies to the more northerly mediterranean climatic zones as well.

In addition, considerable variation of local habitat types and plant communities occurs within each category. For example, inter alia ‘High Andean Steppe’ includes dwarf, bushy overall cover with a highly diverse woody, herbaceous and geophytic flora at lower altitudes (habitat of *T. sessilifolium*), and subnival sparse cushion or specialised scree floras at the limit of flowering plants (habitat of *T. nubigenum*).

Code P is derived from ecological data in ‘Flora Patagonica 1’ (Roig, 1998) and ‘Flora of Tierra del Fuego’ (Moore, 1983).

The remaining two codes are our own. Code T signifies tropical Andean endemic; code E represents taxa from subtropical and tropical eastern-Atlantic exposures.

T01) Humid Bolivian tropical montane forest.

E02) Coastal or adjacent interior subtropical and tropical scrub.

E03) Subtropical gallery forest near the Atlantic coast, or along estuaries and lower reaches of rivers. Also fences and vegetation bordering cultivation.

G04) Pacific desert coastal fog oases of Tocopilla (1.C.13.).

- G05) Pacific desert coastal fog oases of Taltal (1.C.14.).
- G06) Sporadically flowering Pacific desert sector of Huasco (1.C.15.).
- G07) Sporadically flowering desert of the interior lowland plains and levels (1.D.16.).
- G08) Sporadically flowering desert of the interior upland country (1.D.17.).
- G09) High Andean steppe vegetation of Coquimbo Region (2.B.8.).
- G10) Scrubby montane (pre-cordillera) steppe (2.B.9.).
- G11) Xerophytic pre-Andean scrublands (2.B.10.).
- G12) High Andean steppe vegetation of the Santiago mountain ranges (2.B.11.); also those of Mendoza and San Juan Provinces.
- G13) High Andean steppe vegetation of Maule Region (2.B.12.).
- G14) Northern mediterranean system Pacific coastal scrubby steppe (3.A.1.).
- G15) Northern mediterranean system Pacific interior scrubby steppe (3.A.2.).
- G16) Northern mediterranean system mainly Pacific coastal shrubland steppe (3.A.3.).
- G17) Northern and central mediterranean systems subarborescent steppe (3.A.4.).
- G18) Predominantly woody, spiny thicketlands of the central mediterranean system interior uplands (3.B.5.).
- G19) Predominantly woody, spiny thicketlands of the central mediterranean system Pacific coastal range (3.B.7.).
- G20) Predominantly woody, spiny thicketlands of the central mediterranean system Pacific coastal drylands (3.B.8.).
- G21) Central mediterranean system leathery-leaved Pacific coastal woodland (3.C.10.).
- G22) Central mediterranean system leathery-leaved pre-Andean woodland (3.C.11.).
- G23) Southern mediterranean system leathery-leaved montane woodland (3.C.12.).
- G24) Southern mediterranean system leathery-leaved volcanic sand woodland (3.C.14.).
- G25) Southern mediterranean system mountain deciduous woodland (4.A.2.).
- G26) Southern mediterranean system deciduous woodland of Maule district (4.A.3.).
- G27) Southern mediterranean system low montane deciduous woodland (4.A.4.).

- G28) Southern mediterranean system deciduous woodland around Concepción (4.B.5.).
- G29) Southern mediterranean system deciduous woodland fronting the Andes (4.B.6.).
- G30) Central southern inland deciduous woodland (4.B.7.).
- G31) Araucanian deciduous woodland of the volcano and the lake district (4.B.8.).
- G32) Mixed mountain woodland and shrub steppe of the southern Andean heights (4.C.10.).
- G33) Southern evergreen broadleaf Valdivian woodland of Valdivia district (5.A.1.).
- G34) Southern evergreen broadleaf Valdivian woodland of the lake district (5.A.2.).
- G35) Southern evergreen broadleaf Valdivian woodland of Chiloë Island (5.A.3.).
- G36) Southern mediterranean system high Andean shrubby steppe (6.A.1.).
- G37) Southern mediterranean system high woodland of the Nahuelbuta coastal range (6.A.4.).
- G38) Southern deciduous Valdivian woodland of the Aisén district (6.B.9.).
- G39) Open southern evergreen woodland of the bare coastal range heights (7.A.1.).
- G40) Dwarf xerophytic Patagonian scrub-steppe of Aisén (8.A.1.).
- P) Argentina: southern Andean montane and plains steppe from Mendoza to Chubut. Patagonian steppe, including occasional thin arborescent cover, open woodland interface, or, rarely, introduced pine groves and lakeside shore-shingle, including:
- P41) Pure *Mulinum spinosum* cushion shrublet steppe, at times intermixed with degraded or colonising secondary woody associations of primary woodland origin (= 'Flora Patagonica' ecological code 1.4.).
- P42) Patagonian climax steppe types (= 'Flora Patagonica' ecological code 2.2.1.).
- P43) A diverse range of Atlantic to low eastern Andean scrub and subarborescent steppe.
- P44) Seasonally dried-out Patagonian salt lake pans, and marginal fringes of same, rarely in mud, usually beside rivers and lakes. Noted in 'Flora Patagonica' as: Vegetational communities of the marshes, seasonal mudflats and shallow lagoons (= 'Flora Patagonica' ecological code 6.6.1.).

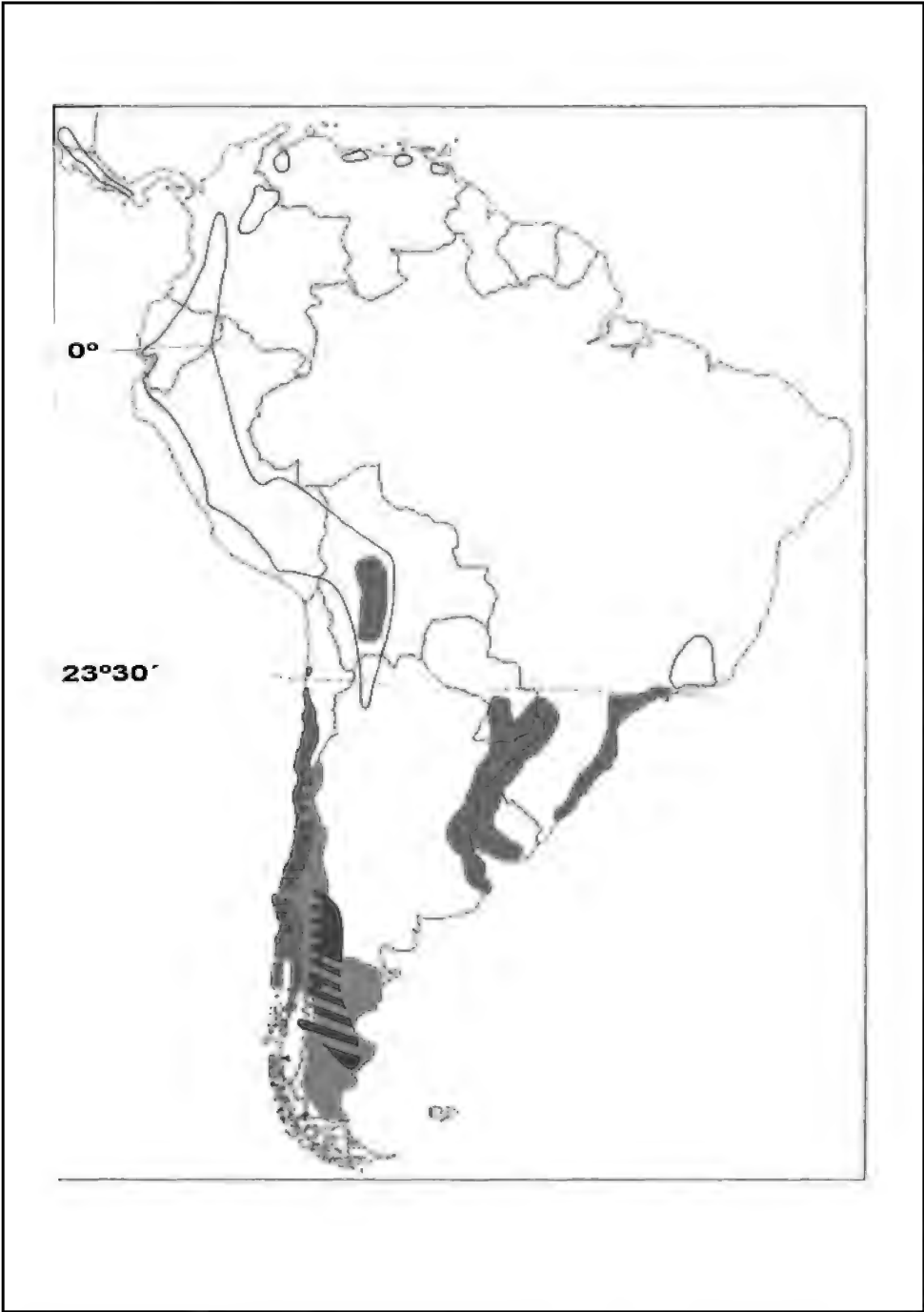


Fig. 1. Full natural geographical distribution (neotropical) of the genus *Tropaeolum* (as also equivalent to the family Tropaeolaceae), indicating the five subsections of *Tropaeolum* sect. *Chilensis*, with sect. *Tropaeolum* outlined for comparison. (After Sparre & Andersson, 1991.)

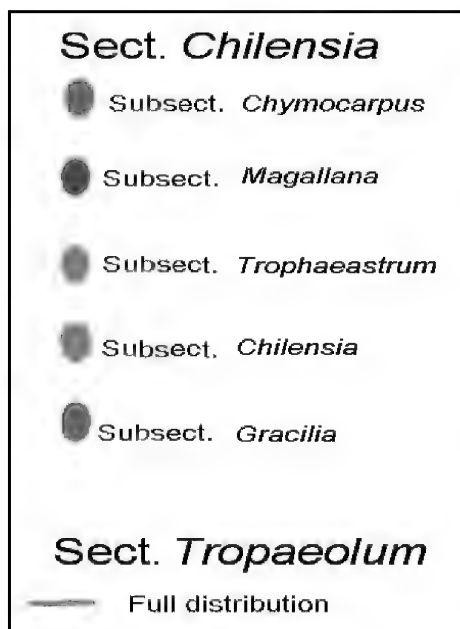


Fig. 2. Colour-code key to the subsections of sect. *Chilensia* of *Tropaeolum* and sect. *Tropaeolum* in map, Fig. 1.



Fig. 3. *Tropaeolum pentaphyllum* subsp. *pentaphyllum* showing diagnostic fleshy berries of subsect. *Chymocarpus*. In cultivation at Christchurch, New Zealand. Photograph (ID CFG9597) by kind courtesy of Country, Farm & Garden Stock Photos (www.cfgphoto.com).



Fig. 4. *Tropaeolum ciliatum* subsp. *ciliatum* (BC & VV 4995) showing diagnostic fleshy berries of subsect. *Chymocarpus*. Recinto, Biobío Region, Chile. January 21, 1972.



Fig. 5. *Tropaeolum speciosum* showing diagnostic fleshy berries of subsect. *Chymocarpus*. Pucon to Lake Caburga, Araucanía Region, Chile. February 17, 2006. Photograph by kind courtesy of M. Belov (www.chileflora.com).

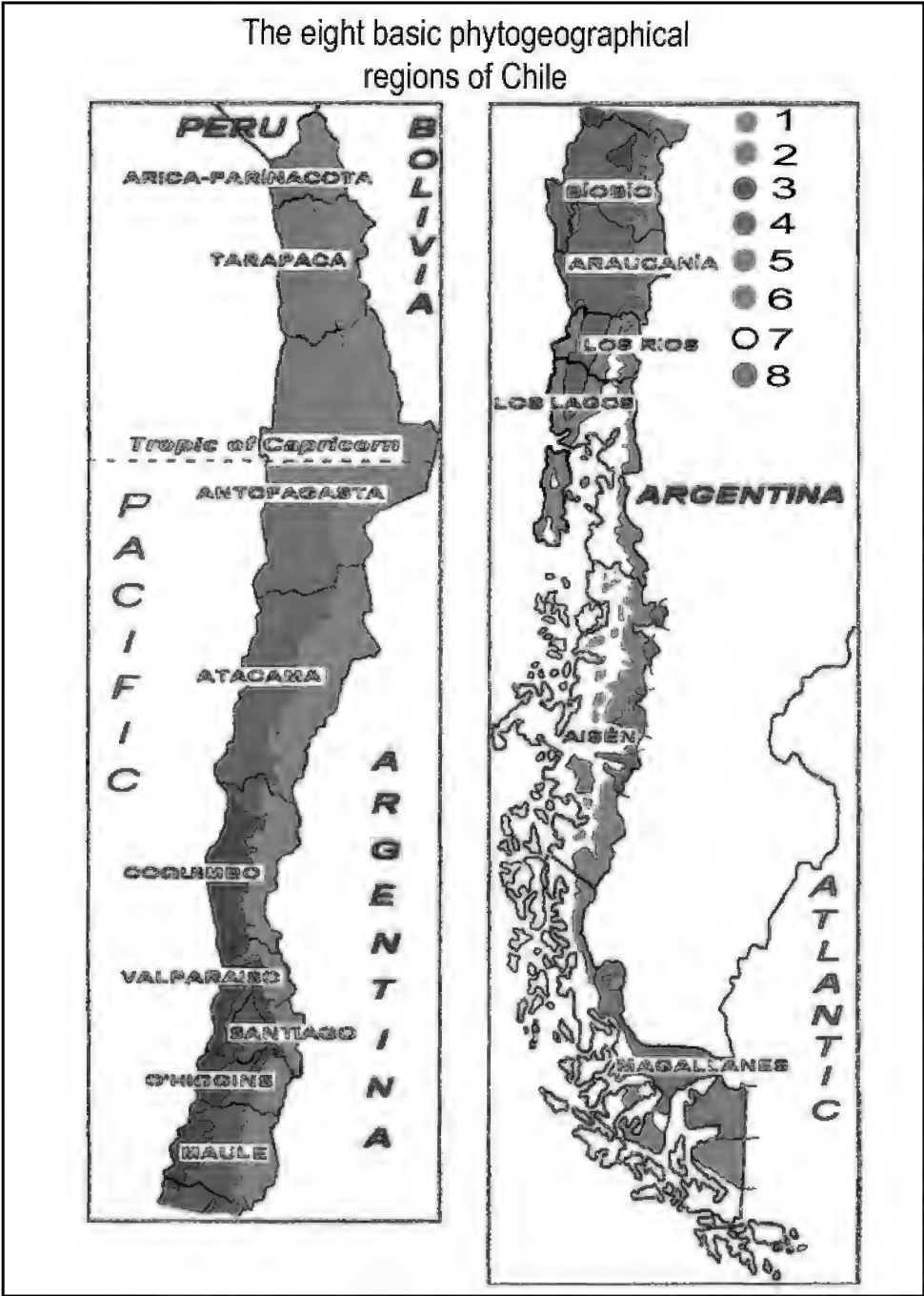




Fig. 7 Panoramic view to the distant Andes encompassing a range of habitats: near habitat - *T. hookerianum* & *T. tricolor*; mid-distant - *T. azureum*, *T. kingii*, *T. looseri* & *T. tricolor*; far cordillera - *T. x jilesii*, *T. looseri*, *T. polyphyllum* & *T. sessilifolium*. Central northern Coquimbo Region, Chile. September 1997.

TAXONOMY

Tropaeolum L. Sp. Pl. 1:345. (1753).

Type: *Tropaeolum minus* L.

Sections: *Tropaeolum*

Chilensia

Distribution: *Tropaeolum* is naturally endemic to Latin America. The genus, which also equates with the family, is principally concentrated along the entire mountainous western (Andino-Pacific) border of South America. It also contains extensions in the southern extremity of Central America below and including Chiapas, Mexico; in Venezuela; in the central Atlantic sector of South America; and in Patagonia. Its maximum N-S span is approximately 10,000 km.

Taxa: At present the count of known and recognised species numbers 94 and the total of taxa comprising the genus stands at 109 (Watson & Flores, 2010a, Garralla & Bulacio, 2010, E. Bulacio, in litt.).

KEY TO THE SECTIONS OF TROPAEOLUM

- 1A. Leaves entire, subentire, lobed to less than ½ blade length, or rarely deeply lobed. When leaves deeply lobed, then flowers either in racemose inflorescences, or with two petals only, or petals deeply and finely lobed to lobulate. Stipules, if present, persistent and large, but never deeply divided or glandular. Petals frequently finely and acutely serrate or lobed at apex, often also ciliate. Flowers at times forming racemose inflorescences. Sect. *Tropaeolum*
- 1B. Leaves petiolulate, divided to base or deeply lobed. If deeply lobed, then flowers and petals never as above. If present, stipules large and deeply divided, or glandular. Petals entire or emarginate, rarely coarsely laciniate at apex. Flowers always solitary on peduncle, at times compressed as terminal or nodal pseudoinflorescences. Sect. *Chilensia*

Tropaeolum sect. *Chilensia* Sparre, Opera Bot. 108:22. (1991).

Type: *Tropaeolum polyphyllum* Cav.

Subsections: *Chymocarpus*

Magallana

Trophaeastrum

Chilensia

Gracilia

Distribution: Apart from human introductions, the two sections are close to being allopatrically tropical and equatorial (sect. *Tropaeolum*), and southern temperate (sect. *Chilensia*). 25 of the 29 taxa of the latter section are exclusively temperate, one being exclusively tropical. The maximum tropical incursion is 600-700 km into the Bolivian Andes. Sect. *Chilensia* is concentrated along the mainly western exposures of the central temperate Andes and their associated lowlands to the Pacific seaboard. It also occurs in Patagonia, and as disjuncts in the Bolivian Andes, around the lower Paraná river basin and the La Plata estuary, and down the Atlantic seaboard of Brazil from just above the tropic line. Its longest extent is ca 5,000 km.

KEY TO THE SUBSECTIONS OF SECT. CHILENSIA

- 1A. Leaf divisions petiolulate, or plants usually with large, persistent stipules. Fruit always a succulent berry. Subsect. *Chymocarpus*
- 1B. Leaf divisions not petiolulate. If present, stipules minute, insignificant and early-caducous. Fruit a dry mericarp.

- 2A. Lower petals folded to form basal pocket. Fruit winged (a samara).
Subsect. ***Magallana***
- 2B. Lower petals not folded, plane at base. Fruit not winged, a
subpyramidal to orbicular mericarp.
- 3A. Mature petioles 0–4mm.
- 4A. Flowers small, ca 10–12 mm long. Spur 1–2mm. Subsect. ***Tropheastrum***
- 4B. Flowers ca 15mm or longer. Spur 5–15 mm.
- 5A. Spur 10–15 mm. If (exceptionally) shorter, then corollas large.
Subsect. ***Chilensia***
- 5B. Spur 5–6 mm. Corollas small to medium. Subsect. ***Gracilia***
- 3B. Mature petioles exceeding 8mm.
- 6A. Plants procumbent to ascending no- to few-branched scramblers. All
or most leaf segments longitudinally upfolded or channelled.
Subsect. ***Chilensia***
- 6B. Plants climbing vines. Leaves, or at least divisions, flat. Subsect. ***Gracilia***

***Tropaeolum* sect. *Chilensia* subsect. *Chymocarpus* (D. Don) J.M. Watson
& A.R. Flores, **subject. nov.****

Basionym: *Tropaeolaceae Chymocarpus* D.Don, (pro genus), ex Brewster,
R.Taylor & R.Phillips cf. D.J. Mabberley in *Taxon* 30(1):15. 1981. (1833).
Synonym: *Tropaeolum* sect. *Chymocarpus* (D. Don) Sparre, *Opera Bot.*
108:43. (1991).

Type: *Tropaeolum pentaphyllum* Lam.

Taxa (6): *T. pentaphyllum* subsp. *pentaphyllum*
T. pentaphyllum subsp. *megapetaloides*
T. pentaphyllum subsp. *megapetalum*
T. ciliatum subsp. *ciliatum*
T. ciliatum subsp. *septentrionale*
T. speciosum

Defining morphology: Vigorous, high climbing, perennial vines with
spreading subterranean tubers. Leaflets sometimes petiolulate. Noticeable
leaf-like stipules may be present. In fruit the calyx lobes persist, expand
radially and become conspicuously coloured or also spotted to draw
attention to a central presence of up to three shiny black, damson-
coloured, or turquoise bird-attracting berries. By macromorphology,
ecology, geographical location and cytology, subsect. *Chymocarpus* appears
to be the most closely related complex of sect. *Chilensia* to sect. *Tropaeolum*

(Hershkovitz et al., 2006, Watson & Flores, 2010a).

Distribution: Northernmost temperate Atlantic coast of Brazil just surpassing the Tropic of Capricorn; Uruguay and Argentina, lower Paraná basin and La Plata estuary; southern sector of tropical Bolivian Andes; and central southern Chilean Pacific coastal and hill country.

Tropaeolum* sect. *Chilensia* subsect. *Magallana* (Cav.) J.M. Watson & A.R. Flores, **subject. nov.*

Basionym: *Magallana* Cav., Icon.:50, (pro genus). (1797).

Type: *Tropaeolum porifolium* (Cav.) L. Andersson & S. Andersson (= *Magallana porifolia* Cav.).

Taxa (2): *T. porifolium*

T. trialatum

Defining morphology: Rather slender, perennial tuberous vines, sometimes procumbent when support is lacking, usually with only 3-4 very narrow leaflets and relatively large yellow flowers. Basal borders of three lower petals folded over to form a pouch or pocket. Fruits dry and conspicuously winged (samaras).

Distribution: Argentina and Chile. Patagonia, east of the Andes, or rarely at the watershed. This is evidently the least encountered of the subsections, since we have been unable to locate any photographic images of either species.

Tropaeolum* sect. *Chilensia* Sparre subsect *Trophaeastrum* (Sparre) J.M. Watson & A.R. Flores, **subject. nov.*

Basionym: *Trophaeastrum* Sparre, Opera Bot. 108:18, (pro genus). (1991).

Type: *Tropaeolum patagonicum* Speg.

Taxa (1): *T. patagonicum*

Defining morphology: Vigorously spreading, prostrate, perennial tuberous herbs a few cm high with subsessile, fleshy, rounded leaflets and small subisomorphic upright white to yellowish cream flowers, the base dull reddish internally. Spur inconspicuous, almost absent. Fruits a basic tricot of large, dry mericarps, as for most of the section.

Distribution: Endemic to Argentina: Patagonia and Fuegia.

***Tropaeolum* sect. *Chilensia* subsect. *Chilensia* J.M. Watson & A.R. Flores, Curtis's Bot. Mag. 27(3):229. (2010)**

Type: *Tropaeolum polyphyllum* Cav.

Taxa (9): *T. sessilifolium*

T. x jilesii

T. looseri

T. leptophyllum subsp. *gracile*

T. myriophyllum

T. incisum

T. leptophyllum subsp. *leptophyllum*

T. polyphyllum

T. nubigenum

(*T. nubigenum* x *T. polyphyllum*)

Defining morphology: Tuberos more or less semi-succulent perennial herbs, prostrate to flopping, sometimes scrambling, rarely climbing. Often stout, usually with solitary unbranched or few-stemmed shoots. Petioles commonly long and straight, little if at all cirrhose. Leaflets entire or to varying degrees divided into lobes or teeth; usually folded upwards (channelled) when mature, if not then orbicular and subsessile. Flowers frequently yellow, as a rule large and conspicuous, but very uncommonly almost included within calyx. They may cluster at the shoot apex to form pseudo-inflorescences. Spur prominent, 10-25 mm, very exceptionally less, down to 2 mm.

Distribution: Sect. *Chilensia* is essentially Andino-Patagonian, although it descends to the lower foothills on occasions and even rarely to coastal hills in the south. The northern extent is the Chilean southern Atacama Region at the interface of the mediterranean and desert climatic zones, while in the south it reaches as far as central Patagonia in Argentina, but always within reasonable proximity to the Andean chain.

Tropaeolum* sect. *Chilensia* subsect. *Gracilia J.M. Watson & A.R. Flores, Curtis's Bot. Mag. 27(3):230, (as sphalm. *Graciles*). (2010).

Type: *Tropaeolum brachyceras* Hook. & Arn.

Taxa (11): *T. azureum*

T. tricolor

T. x tenuirostre

T. brachyceras

T. hookerianum subsp. *hookerianum*

T. hookerianum subsp. *pilosum*

*T. beuthii**T. austropurpureum**T. nuptae-jucundae**T. rhomboideum**T. kingii*(*T. beuthii* x *T. tricolor*)(*T. hookerianum* subsp. *pilosum* x *T. tricolor*)(*T. nuptae-jucundae* x *T. tricolor*?)(*T. rhomboideum* x *T. tricolor*)

Defining morphology: Usually perennial and tuberous, but possibly facultatively annual under local drought stress circumstances. Slender, delicate, climbing, twining vines, occasionally procumbent or flopping when lacking support. Petioles sensitive and cirrhose. Leaves herbaceous, usually tender, green, and as a rule plane, but leaflets at least always flat. Flowers vary notably in shape and colour. Taxa hybridise somewhat in the wild and freely in cultivation.

Distribution: Endemic to Chile. Mainly throughout entire central mediterranean climatic region, from the Pacific littoral inland to the lower Andean zones. Some intermittent extension northwards occurs along the more fertile desert, including disjunct coastal fog oasis enclaves to slightly within the tropics. In the south also inhabiting less humid fringes of the Valdivian forest sector.

NOTES: Although subsect. *Gracilia* appears to be very polymorphic in flower colour and spur length, all but one of the species are known to hybridise, some freely, both in habitat and artificially, notably the most distinct-looking of them, *T. tricolor*.

It is interesting to speculate on the intriguing phenomenon of increasing spur length from south to north in subsect. *Gracilia*. Our support for the following hypothesis is mostly drawn from Procter et al. (1996) coupled with our own observations and deductions.

Notable spur length in the genus may be seen to have developed as three major lines, which certainly overlap to a limited degree. The most obvious and frequent has resulted from co-evolution with hummingbirds (ornithophily), a predominant, but not quite exclusive phenomenon of sect. *Tropaeolum* in low montane to lower alpine elevations of the tropical Andes at ca 500 to somewhat over 3000 m (Sparre & Andersson (1991).

One of the other two branches is distributed along the temperate Andino-Patagonian sector, probably with its primitive origins during the early Tertiary among the ancestors of subsects *Magallana* and *Chilensia*, reaching its full present expression in the latter subsection. The third extension occurred in the mediterranean-Pacific clade, subsect. *Gracilia*. It is akin to the Andean group in being of somewhat generalised mixed bird and longer to long-tongued insect pollination syndromes. Without doubt, however, we may deduce from flower colours and observation of visits that insects have played a far larger part in its development, and continue to do so, as for most flowering plants throughout the world (Proctor et al., 1996).

So why, with the logical exception of distinctly ornithophilous *T. tricolor*, the almost even phytogeographical increase of spur length in subsect. *Gracilia*? Again we must turn to Proctor et al. for their synopsis of evolutionary trends in flowers. To summarise and interrelate the important aspects in this case: primitive generalists led to early specialists, with a tendency to revert to more advanced generalists, except where stable climate and ecosystems, or specific circumstances have favoured later specialisation and continue to do so. Generalisation and specialisation both bring their benefits and disadvantages, but all other factors being equal, the 'belt and braces' spread of generalisation is a safer cushion for survival, in particular by reducing the risk of extinction due to extreme interdependence and changing environmental factors. For our speculative answer we look to climatic variations and their effects between the mid-southern and northern regions of Chile, approximately 37°S and the Tropic of Capricorn respectively. From roughly 32° to 37°S the climate is relatively stable, with fairly regular and reliable annual precipitation – if variable from season to season, and increasingly so the further north. Above the 32nd parallel the general climate becomes ever more unpredictable, stressful, and dependant on the cyclical El Niño (Southern Oscillation) phenomenon with its intense accompanying rainfalls and long interregna of droughts, these often lasting a decade or more. This reaches its climax in the Pacific influenced Atacama above 28°S, the so-called Chilean Flowering Desert. Living organisms there have adapted to prolonged periods of total dormancy. When sufficient precipitation does arrive, it triggers a brief, frenetic and spectacular explosion of interacting life of all kinds.

Taking our tropaeolums and grossly simplifying. At the southern extreme, where we find the short-spurred *Tropaeolum nuptae-jucundae*

Sparre, the relatively reliable, favourable conditions have led to the establishment of stable plant communities and a wide range of pollinator types. Clearly a subtle mix of generalisation within specialisation has paid here, with the spur inviting tongued insects only, but its brevity making it equally accessible to short- and long-tongued pollinators. At the other, desert, extreme, a sudden ephemeral, seething outburst of flowers and attendant pollinators, mainly insects of all types and adaptations, leads to massive instant demand and universal competition for survival needs. Medium and long-tongued insects such as bees, butterflies, moths and some flies are particularly abundant, and incoming hummingbirds also play a part. Profusely predominant and flamboyant generalists of the Portulacaceae and Malvaceae families in particular provide for beetles, flies and other insects without developed mouth-parts. So the advantage of catering exclusively for the host of long-tongued pollinators, as does *T. beuthii*, is patently obvious. We need only add here that this process of increasing spur length is of course graded over the full distribution of the subsection, and also that there are twin parallel but equivalent littoral and inland strands of gradated spur evolution, presumably adapted to similar climatic circumstances but different specific pollinators. Interestingly too, there is a corresponding increase in petal size.

Which came first? Are longest-spurred *T. beuthii* and *Tropaeolum kingii* Phil. relicts or recent developments, or perhaps both? The clade tree offers no evident clues (Hershkovitz et al. 2006), with all branches ending on a more or less level plane. The likelihood is that adaptive radiation of the subsection has been both recent and rapid across the board, leaving no clear surviving ancestral traits. This is strongly supported by the apparent fully inclusive hybrid compatibility of virtually all its taxa.

GENERAL NOTE: No cross-subsectional hybridisation is known, either in the wild or in cultivation. A natural hybrid swarm between *T. nubigenum* and *T. polyphyllum* is suspected at one point which lies at their potential altitudinal interface (pers. obs.). *Tropaeolum* x *jilesii* Sparre emend. J.M. Watson & A.R. Flores is of infra-subsectional hybrid origin. *T. polyphyllum* occasionally produces populations or forms with somewhat divided leaflets, which may denote hybrid origin. Hybrids between subsect. *Chilensia* taxa have also been produced artificially (Sparre & Andersson, 1991).

As stated in the Introduction, it is intended to treat hybridisation in sect. *Chilensia* apart in detail later.

KEY TO THE TAXA OF SECT. *CHILENSIA**

- 1A. Fruit a samara. Lower petals folded to form pocket at base.
- 2A. Spur 10-20 mm, longer than upper calyx lobes. 7. *T. porifolium*
- 2B. Spur 4-10 mm, ca equal to upper calyx lobes. 8. *T. trialatum*
- 1B. Fruit a wingless nut or berry, lower petals not folded at base.
- 3A. Leaf segments petiolulate. Petals usually 2.
- 4A. Petals small, not exceeding calyx lobes. 1. *T. pentaphyllum*
subsp. *pentaphyllum*
- 4B. Petals exceeding calyx lobes.
- 5A. Calyx lobes elongate-triangular, acute. 2. *T. pentaphyllum*
subsp. *megapetaloides*
- 5B. Calyx lobes rounded, mucronate. 3. *T. pentaphyllum*
subsp. *megapetalum*
- 3B. Leaf segments divided to base or deeply lobed, never petiolulate. Petals 5.
- 6A. Plants often with persistent stipules and bracteoles. Most leaves over 4 cm diameter, plane. Fruit a fleshy berry.
- 7A. When present, stipules deeply lobed, eglandular. Flower red. Spur 25-35 mm. Upper petals 12-16 mm. Mature fruit blue. 6. *T. speciosum*
- 7B. When present, stipules and bracteoles with glandular margin. Flower ochreous yellow, more or less veined or tinged dull red. Spur 4-12 mm. Upper petals 4-8 mm. Mature fruit black.
- 8A. Spur stout, 4-7 mm. 4. *T. ciliatum*
subsp. *ciliatum*
- 8B. Spur slender, 8-12 mm. 5. *T. ciliatum*
subsp. *septentrionale*
- 6B. Plants estipulate and ebracteolate. Most leaves less than 4 cm diameter, if more, then not plane. Mature fruit a dry mericarp.
- 9A. Flowers small to medium, longest petals not exceeding 12 mm. Leaves mainly thin, sometimes succulent.
- 10A. Leaves usually green, delicate, herbaceous. Petioles markedly cirrhose.
- 11A. Petals blue to purple, occasionally white, pink or pale lilac.
- 12A. Spur 2-3 mm long. 19. *T. azureum*
- 12B. Spur 5-6 mm long. 26. *T. austropurpureum*
- 11B. Petals pale parchment to deep yellow, rarely greenish.

- 13A. Leaves slightly fleshy, sometimes subglaucous. Upper petal blades twice the area of lower blades. All petals distinctly emarginate. 28. *T. rhomboideum*
- 13B. Leaves always green. All petal blades closely similar in area, entire or more rarely emarginate.
- 14A Spur to 4 mm, sometimes distinctly swollen at apex.
- 15A. Spur 2-3 mm. Petals 8-12 mm long. 19b. *T. aff. azureum*
- 15B. Spur 3-4 mm, tip swollen. Petals 3-4 mm long. 27. *T. nuptae-jucundae*
- 14B. Spur over 4 mm, not distinctly swollen at apex.
- 16A. Spur to 6 mm.
- 17A. Peduncles short, to ca 20 mm. Petals 4-8 mm long. Flowers solitary and regularly spaced along stem.
- 18A. Petals 6-8 mm long. Spur all-green, 4-5 mm. 22. *T. brachyceras*
- 18B. Petals 4-5 mm long. Spur bicolored, green and brownish to reddish, 4-6 mm long. 21. *T. x tenuirostre*
- 17B. Peduncles long, ca 30-50 mm. Petals 8-10 mm long. Flowers often congested in bunched nodal groups along stem.
- 19A. Peduncles glabrous to subglabrous. 23. *T. hookerianum*
subsp. *hookerianum*
- 19B. Peduncles distinctly and strongly pilose. 24. *T. hookerianum*
subsp. *pilosum*
- 16B. Spur exceeding 6 mm.
- 20A. Petals brownish or greenish yellow to yellow, large. Spur slender, 8-13 mm.
- 21A. Flowers bright yellow. Spur straight, unmarked. Leaf segments lanceolate to spatulate. 25. *T. beuthii*
- 21B. Flowers old ivory-, bleached parchment-brown, faded greenish yellow or pale lemon. Spur upcurved, striated lengthwise. Leaf segments linear or sublinear. 29. *T. kingii*
- 20B. Petals yellow or greeny, small. Spur stout, 6-25 mm.
- 22A. Spur 6-20 mm, green and brown to reddish. Petals clearly exceeding calyx, yellow, the upper pair veined. 21. *T. x tenuirostre*
- 22B. Spur ca 20-25 mm, red to pale orange, rarely yellow. Petals included or scarcely exceeding calyx, yellow or greeny, unmarked. 20. *T. tricolor*

- 10B. Leaves rather thick and succulent, glaucous. Petioles not or scarcely cirrhose.
- 23A. Leaf segments small, suborbicular, obtuse, to 10 mm. Petioles not exceeding 5 mm. Petals either approximately equalling, or exceeding calyx, white, cream, pink, sometimes violet-tipped. Throat of corolla yellow, orange, or dull reddish.
- 24A. Petals 4-6 mm, scarcely exceeding calyx. Throat of corolla dull reddish. **9. *T. patagonicum***
- 24B. All petals longer than 8 mm and exceeding calyx. Throat of corolla orange or yellow. **10. *T. sessilifolium***
- 23B. Leaf segments lanceolate, acute, 10 mm or more. Petioles 20 mm or more. Petals not, or scarcely exceeding calyx, always rich orange overall, upper pair prominently red-veined. **18. *T. nubigenum***
- 9B. Flowers large, longest petals not shorter than 12 mm. Leaves always somewhat fleshy.
- 25A. Leaf segments small, rarely exceeding 12 mm long, divisions usually 3, rarely to 6. At least central lobe suborbicular, obtuse. Flowers whitish, pinkish or yellow.
- 26A. Leaf segments entire. Petioles not exceeding 5 mm. Flowers whitish or pinkish, sometimes violet-tipped: throat orange. Lower petals obovate-cuneate. **10. *T. sessilifolium***
- 26B. One or usually more leaf segments lobed. Petiole 4-35 mm. Flowers all-yellow, upper pair lightly red-veined. Lower petals quadrate to occasionally somewhat cuneate-ovate. **11. *T. x jilesii***
- 25B. Leaf segments linear to lanceolate, rarely somewhat orbicular; if less than 12 mm long, then linear or narrowly lanceolate. Leaf divisions of closely equivalent dimensions. Flowers yellow, orange, red, pink or white.
- 27A. Leaf segments entire, or one or two somewhat incised.
- 28A. Leaf segments always entire.
- 29A. Leaf segments broadly lanceolate, 5-12 mm wide. Spur 10-12 mm. **17. *T. polyphyllum***
- 29B. Leaf segments linear to narrowly lanceolate, 2-3 mm wide. Spur 20-22 mm.
- 30A. Leaf segments 10 mm or more long. Petals usually bright yellow, rarely as all-white populations **16. *T. leptophyllum***
subsp. ***leptophyllum***

- 30B. Leaf segments 7 mm or less long. Petals bright to paler yellow.
 13. *T. leptophyllum*
 subsp. *gracile*
- 28B. Few leaf segments divided, commonly the central lobe only; most entire.
- 31A. Leaf segments broadly lanceolate, 5-12 mm wide. Spur 10-12 mm.
 17. *T. polyphyllum*.
- 31B. Leaf segments linear to narrowly lanceolate, 2-3 mm wide. Spur 17-30 mm.
- 32A. Leaf segments 10 mm or more long. Petals usually bright yellow.
- 33A. Plant decumbent, densely foliate Inflorescence more or less compact, terminal, multi-flowered. Rarely white-petalled.
 16. *T. leptophyllum*
 subsp. *leptophyllum*
- 33B. Plant climbing, scrambling or procumbent-flopping, loosely and openly foliate. Inflorescence usually spaced-out and rather few-flowered.
 12. *T. looseri*
- 32B. Leaf segments 7 mm or less long. Petals bright to paler yellow.
 13. *T. leptophyllum*
 subsp. *gracile*
- 27B. All or most leaf segments incised or lobed.
- 34A. Leaf segments narrowly linear-lanceolate, acute. Lower petals obovate-cuneate.
 14. *T. myriophyllum*
- 34B. Leaf segments broader, often obtuse and obtusely lobulate. Divisions of segments often mucronulate. Lower petals obovate-truncate or quadrate, rarely cuneate.
- 35A. Lower petals more or less abruptly quadrate to occasionally somewhat cuneate-subquadrate. Spur base slender. Flowers diffusely spread along upper stem.
- 36A. Leaf divisions 5-9, commonly 7. Petiole ca, 30-40 mm. Spur 20-25mm.
 12. *T. looseri*
- 36B. Leaf divisions usually 3-5, rarely to 6(-7). Petiole 4-20 mm, seldom longer. Spur usually ca 8-15mm, rarely 2-8 mm, never exceeding 20 mm.
 11. *T. x jilesii*
- 35B. Lower petals obovate. Spur base broadly conical. Flowers clearly bunched at apex of fertile shoot.
 15. *T. incisum*

(*Note: The widespread nothospecies *Tropaeolum x tenuirostre* Steud. is accepted and treated as a species de facto in all relevant recent floristic

treatments, so it has been included in the key and descriptive entries. *T. x jilesii* is likewise hybridogenous and not yet stabilised, and is classified here as such for the first time. It is also sufficiently established and well distributed in the wild to justify admittance per pro species. Other rare and very local natural hybrids - as quoted in parentheses above - have been omitted. They are usually difficult or impossible to define morphologically, and can only be identified with certainty in situ in the immediate presence of both parent species.)

I. SUBSECT. *CHYMOCARPUS*

01. *Tropaeolum pentaphyllum* Lam., Encycl. 1(2):612. (1785) subsp. *pentaphyllum*.

Type: Argentina, Buenos Aires and Uruguay, Montevideo, Commerson **s.n.** (lectotype: LINN-Sm. isotypes: BM, G, NY, P).

Syns: *Tropaeolum quinatum* Hell., De Tropaeolo 20. (1789).

Chymocarpus pentaphyllus (Lam) D. Don, Trans. Linn. Soc. London 17(1):14. (1834).

Tropaeolum chymocarpus Morong, Bull. Torrey Bot. Club 16:44. (1889).

Trophaeum pentaphyllum (Lam.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Trophaeum quinatum (Hell.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Defining morphology: Vigorous subtropical, arboreal vine, probably predominantly ornithophilous (bird pollinated and distributed), with very small red or reddish petals, usually the upper two only present, occasionally also the lower three. Petals do not exceed the calyx. Flowers are followed by the conspicuous, persistent calyx, which turns violet- to reddish purple and displays 1-3 dark grey-blue, smooth, fleshy berries.

Distribution: Atlantic coast and lower Paraná river basin and La Plata estuary at the conjunction of Brazil, Paraguay, Uruguay and Argentina in a square roughly 1000 km across almost reaching north to the Tropic of Capricorn. Our coding for this is (E2 & E3).

Elevations: Lowlands, probably from near sea level to scarcely exceeding ca 100 m.

Habitat and ecology: Gallery forest, almost certainly mainly or entirely at light margins, in clearings and along river courses; also fences bordering gardens and cultivation boundaries (E. Bulacio, in litt.).

Population status: Apparently widespread and common.

Year of introduction: Sparre & Andersson (1991) estimate it was in cultivation ca 1730.

02. *Tropaeolum pentaphyllum* subsp. *megapetaloides* Sparre, Opera Bot. 108:46. (1991).

Type: Brazil, Paraná State, Curitiba, Braga **90** (holotype: S, isotype: IPB).

Syn.: *Tropaeolum pentaphyllum* subsp. *megapetalum* auctt. non (Buchenau) Sparre.

Defining morphology: Differs from the type subspecies by having larger petals which clearly exceed the calyx, and some dark maculation on the interior of the elongated, triangular calyx lobes.

Distribution: Endemic to south-eastern Brazil, along the Atlantic coast south from the Tropic of Capricorn, forming the base of a triangle extending ca 400 km inland.

Elevations: Near sea level to ca 800 m.

Habitat and ecology: Is said to grow mostly in scrubland and so probably drapes as much as it climbs. We have qualified this as (E2).

Population status: According to the number of collections recorded, it is not uncommon.

03. *Tropaeolum pentaphyllum* subsp. *megapetalum* (Buchenau) Sparre, Fl. Illustr. Catarin. 1 (Tropaeolaceae):8. (1972).

Basionym: *Tropaeolum pentaphyllum* var. *megapetalum* Buchenau, Bot. Jahrb. 22:169. (1896).

Type: Bolivia, Santa Cruz Department, Sierra de Santa Cruz, Kuntze **s.n.** (lectotype: NY, isotype: F).

Defining morphology: Similar to subsp. *megapetaloides* in possessing larger petals which exceed the calyx, but differing from both other subspecies by the strongly dark-maculate petals, densely dark-maculate calyx and from subsp. *megapetaloides* by its rounded calyx lobes.

Distribution: Endemic to Bolivia, on the eastern slopes of the Andes with a range of about 750 km from Cochabamba to Tarija.

Elevations: 1500 to 3100 m.

Habitat and ecology: Humid montane or *yunga* forest and woodland, probably at lighter margins and along river courses. We have devised the code of (T1) to cover this.

Population status: Apparently not uncommon judging from the number of collections and difficulty of the terrain.

04. *Tropaeolum ciliatum* Ruiz & Pav., Fl. Peruv. 3:77. (1802) subsp. *ciliatum*.

Type: Chile, Bío Bío Region, Concepción, Talcahuano, Dombey **s.n.**
(lectotype: P, isotype: M).

Syns: *Trophaeum ciliatum* (Ruiz & Pav.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Tropaeolum venosum Phil. ex Buchenau, Bot. Jahrb. 15:204. (1892).

Defining morphology: Vigorous arboreal vine with rather small, dark reddish veined, slightly dull or dark orangey or yellow, or ochreous pale yellow flowers with a spur of 4-7 mm. After anthesis the persistent calyx spreads, reddens and displays 1-3 shiny, jet-black, fleshy berries.

Distribution: Endemic to southern central Chile. The range covers approximately 300 km between the countryside surrounds of Concepción and Temuco.

Elevations: A few hundred metres above sea level to ca. 1000 m on the Andean footslopes.

Habitat and ecology: Four Gajardo categories (G23, G24, G28 & G30) are inhabited by this taxon – either of xerophyllous or deciduous woodland. It favours clearings and more open arboreal cover, where it can reach up to the light readily or cover an exposed and sunny wayside or copse fringe.

Population status: Common and widespread.

Year of introduction: *T. ciliatum*, apparently as both subspecies, is well established as a garden plant, although it has not been possible to trace when either arrived, or which of them was the first in cultivation.

NOTE: The monograph (Sparre & Andersson, 1991) states that a description of red flowers for *T. ciliatum* s.l. by Barnéoud cannot apply to the species. However a degree of red tingeing of the upper petals may be encountered, and occasionally entire corollas become red at maturity (see Watson & Flores, 2010a:201, Fig. 1). This may perhaps be indicative of the beginning of a selection process by hummingbird preference.

05. *Tropaeolum ciliatum* subsp. *septentrionale* Sparre, Opera Bot. 108:25. (1991).

Type: Chile, Valparaíso Region, La Troya, ca 12 km from Limache, 400-600 m, Morrison **16728** (holotype: S, isotypes: G, GH, K, LIL, MO, SI, UC).

Defining morphology: Apart from their distinct geographical distributions, subsp. *septentrionale* is most clearly distinguished from the type by the distinctly longer, more slender spur. It also tends to be even more vigorous and rather larger leaved.

Distribution: Endemic to central Chile. Similar in geographical span to the range of the type subspecies, but separate and to the north, between Valparaíso Region and Curicó.

Elevations: From a few hundred metres in the valleys to about 2000 m inland.

Habitat and ecology: Three Gajardo categories are represented (G21, G22 & G23), all types with dominant xerophyllous tree cover. The general habitat tendencies are similar to the type subspecies, but its ecology is drier and hotter, broadly speaking. We have seen it smothering small trees and large shrubs with an almost unbroken sheet of foliage and flowers. It particularly favours valleys and other depressions, probably because the tree support there is more developed through greater subterranean-drainage moisture accumulation, which also probably facilitates germination and root growth.

Population status: Common and widespread.

Year of introduction: See above under *T. ciliatum* subsp. *ciliatum*.

06. *Tropaeolum speciosum* Poepp. & Endl., Nov. Sp. Gen. Pl. 1:22. (1835).

Type: Chile, Bío Bío Region, Quillay-Leveu to Antuco, Poeppig **930**

(lectotype: W, isotypes: BM, F, G, L, LE, M, MA, MO, OXF, P, US, W).

Syns: *Chymocarpus speciosus* (Poepp. & Endl.) Walp., Ann. Bot. Syst. 1:142. (1848).

Tropaeolum lechleri Steud., Flora 39(28):440. (1856).

Anisocentra cardiopetala Turcz., Bull. Soc. Imp. Naturalistes Moscou 36:592. (1863).

Trophaeum lechleri (Steud.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Trophaeum speciosum (Poepp. & Endl.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Defining morphology: Unmistakably distinct both in flower and fruit. A vigorous vine with spreading tuberous rootstock. The only temperate species with large, entirely bright red flowers, these including prominent, spreading petals and a long spur. Also unique for its bright turquoise-blue, succulent fruits, which darken with age.

Distribution: Southern Chilean endemic covering 1300 km between Concepción and the Chonos Archipelago.



Fig. 8 *Tropaeolum ciliatum* subsp. *septentrionale* (F&W 8234). Cerro Roble, Valparaíso Region, Chile. December 1994.



Fig. 9 *Tropaeolum speciosum* (C&W 5032). Vilcún, Araucanía Region, Chile. February 3, 1972.

Elevations: Near sea-level to over 1000 m.

Habitat and ecology: An impressive ten Gajardo categories apply (G28, G29, G30, G31, G32, G33, G34, G35, G38 & G39), but all essentially variations on humid southern woodland or temperate rainforest defined by predominant species of trees. As seen the species inhabits waysides, woodland and forest borders or climbs through *Chusquea* bamboo brake, a particularly favoured habitat.

Population status: Widespread and frequent, but often as isolated plants rather than locally common populations. It appears to be the only species of sect. *Chilensia* not only to have established as an adventive elsewhere in the world, but also to have become a serious weed pest, at least in New Zealand (Harman, 2006).

Year of introduction: 1846 (Paxton & Hereman, 1868, Sparre & Andersson, 1991).

NOTE: Discussion of the probable evolution of *T. speciosum*, including speculation of a possible complimentary and competitive relationship with *T. tricolor*, may be found in Watson & Flores (2010a).

II. SUBSECT. *MAGALLANA*

07. *Tropaeolum porifolium* (Cav.) L. Andersson & S. Andersson, Taxon 49(4):733. (2000).

Basionym: *Magallana porifolia* Cav., Icon. [Cavanilles] 4:51, Tab. 374. (1797).

Type: Argentina, Santa Cruz Province, Puerto Deseado, Née **s.n.** (lectotype: MA, isotype: CONC).

Syns: *Magallana porrifolia* Pers., Syn. Plant 1, (sphalm.). (1805).

Magallana cavanillesii Scala, Rev. Mus. La Plata 32:23. (1929).

Defining morphology: The following otherwise unique features are shared with *T. trialatum*: pouched lower petals on flower, conspicuously winged fruits in seed, and in the sterile state (3-)4(-5) linear leaflets only, each no more than 4 mm wide. The specific difference is the longer spur of *T. porifolium*, to 20 mm and twice as long as the calyx lobes.

Distribution: Mainly Argentinian Patagonia, but also found once in Chile. Widespread but diffuse over more than 1600 km between southern Mendoza Province and the Atlantic coast of Santa Cruz.

Elevations: From near sea level to 2000 m.

Habitat and ecology: One Gajardo category (G40), low xerophyllous scrub of the Patagonian steppe. However, its occurrence in Chile is marginal, and

it undoubtedly occurs in a greater range of local plant communities across Argentinian Patagonia, probably including mulinum steppe and low arborescent climax steppe. We have categorised these tentatively as (P41, P42 & P43).

Population status: Scattered but apparently not uncommon over its total area of distribution. Has been reported as forming local colonies at one site.

NOTE: The winged mericarps or samaras are an interesting and unique feature in the section. We speculate their existence is related to powerful prevailing winds on the generally flat Patagonian steppe, and the consequent potential for effective diffusion. However, those southern winds have such force that transportation could easily become disadvantageous, with the relatively few fruits being scattered beyond effective breeding range, or even driven out to sea! It therefore seems likely that some evolutionary development of the dispersal mechanism may counter that. Weight of the fruits may help to keep flight under control. Perhaps too the wings are relatively fragile and disintegrate or detach readily, or alternatively they may trap the airborne fruits in the very shrubs required for the future plant's support.

08. *Tropaeolum trialatum* (Suess.) L. Andersson & S. Andersson, Taxon 49(4):733. (2000).

Basionym: *Magallana trialata* Suess., Repert. Spec. Nov. Regni Veg. 30:276. (1932).

Type: Argentina, Neuquén Province, Cobunco, 700 m, Ammann **105** (holotype: M, isotype: F).

Defining morphology: Close to *T. porifolium*, but differing in the even finer linear leaflets less than 1 mm wide and shorter spur to 10 mm, roughly equal in length to the calyx lobes.

Distribution: Endemic to Argentina, northern Patagonia. Confined to a very restricted area, mainly within Neuquén Province but also in the north of Río Negro, and from small sectors of La Pampa and Chubut.

Elevations: Between 250 m and perhaps 2000 m.

Habitat and ecology: Presumably similar to *T. porifolium*, but restricted to the habitat within its more limited distribution. We conjecture this to be our Patagonian type (P41).

Population status: Despite its limited area of occurrence it seems from the number of collections recorded to be relatively securely established. Its abundance within its local colonies is unknown to ourselves.

NOTE: Floral organs of *T. trialatum* are generally smaller or less developed, suggesting a more primitive evolutionary position. Its spur is 4-10 mm, compared with 10-20 mm in *T. porifolium*, which probably therefore contains more nectar and attracts longer-tongued pollinators. The petals of *T. trialatum* are also notably smaller and less conspicuous. We conclude that due to the more advanced characteristics of its flowers, *T. porifolium* is a later, more effectively evolved and successful species in direct competition with *T. trialatum*. This has led to the former's wide-ranging dispersal, whereas *T. trialatum* has remained localised within a narrow distributional perimeter. This may signify it could be heading towards natural extinction.

III. SUBSECT. *TROPHEASTRUM*

09. *Tropaeolum patagonicum* Speg., Revista Fac. Agron. Univ. Nac. La Plata 3:599. (1897).

Type: Argentina, Chubut Province, Teka-choique, Moyano **s.n.** (holotype: LP).

Synonym: *Trophaeastrum patagonicum* (Speg.) Sparre, Opera Bot. 108:18 (1991).

Defining morphology: Distinctive and unmistakable. A very small, creeping, rhizomatous herb a few cm high equipped with tubers, and with succulent, rounded leaflets. The almost regular upright flowers only slightly exceed the foliage in size. It looks quite unlike a *tropaeolum* except when the disproportionately large, typical, dry, dark tricot mericarps are present.

Distribution: Endemic to Argentina, Patagonia. Extremely intermittent and scattered over ca 1500 km between Chubut Province and Tierra del Fuego.

Elevations: Near sea level to ca. 800 m.

Habitat and ecology: In their phytogeographical analysis of sect. *Chilensia*, Hershovitz et al. (2006) mistakenly classified *T. patagonicum* as a mesophyte, which contributed to their conclusions. We have categorised its highly selective Patagonian habitats as (P44). This remarkable little specialist has adapted to seasonal (winter) flooded river and lake borders, also to seasonal (spring and summer) exposed beds of shallow, temporary lagoons, which have drained and evaporated. The waters of these must at times become mineral-saturated in the long term, in which case a halophytic and salt-tolerant community will have developed. Rushes, sarcocornias, distichlis, spartinas and frankenias are typical

marginal elements. But these vigorous colonisers seem unable to tolerate too prolonged a period of submergence, often leaving the areas of persistent winter water-cover free of stifling competition, to the benefit of a dispersed, better adapted dwarf flora, of which *T. patagonicum* is an element. It may typically be seen threading along cracks separating shrunken dried mud ‘pavement’ slabs, looking like nothing more than a garden crazy-paving denizen! We have also seen a very small colony in a mixed dwarf community growing on the shingle of a seasonally dry lake shoreline. Moore (1983) provides a description of its ecology at its southernmost known location, as also corresponds to that limit for the family.

Population status: Exists only as local populations in its widely spaced and extremely specialised ecological niche. Such populations may consist of a few individuals only, but are usually quite dense and numerous, and often dominant over a limited area.

Year of introduction: Seeds were distributed by ourselves at the beginning of the 21st Century, but apparently failed to respond to cultivation.

NOTE: Sparre and Andersson (1991) founded Sparre’s new genus *Trophaeastrum* largely on the basis of what Sparre perceived as its spurless or subspurless calyx (‘Calyx ecalcarate or almost so’). Artificial crosses in the *T. brachyceras* group (subsect. *Gracilia*) have produced progeny with completely spurless flowers (R. Wilson, 2007, in litt.). These have appeared in informal reports under the unfortunate invalid generic epithet of *Trop(h)aeastrum* as well as with the equally unfortunate rank of ‘sp.’ (e.g., Jones 2008:101). Unfortunate because any cross between two taxa of the same genus is a hybrid not a species. Nor can such a cross under any circumstances be named as a different genus, or even in fact as a hybrid genus (nothogenus), which would fail to conform with ICBN Article H.7 (McNeill et al., 2006). This applies whether the invalidly proposed genus already exists or not, and even if the cross is considered to be a genetic ‘throwback’ exhibiting traits of that presumed ancestor. In any case these particular impressive *Tropaeolum* hybrids develop large, distinctly zygomorphic flowers, a feature in direct contradiction to the original circumscription by Sparre (Sparre & Andersson, 1991). An image of one may be seen in Jones (2008). It certainly seems reasonable to hypothesise that such ‘Spurless Wonders’ are probably the result of a latent ancestral

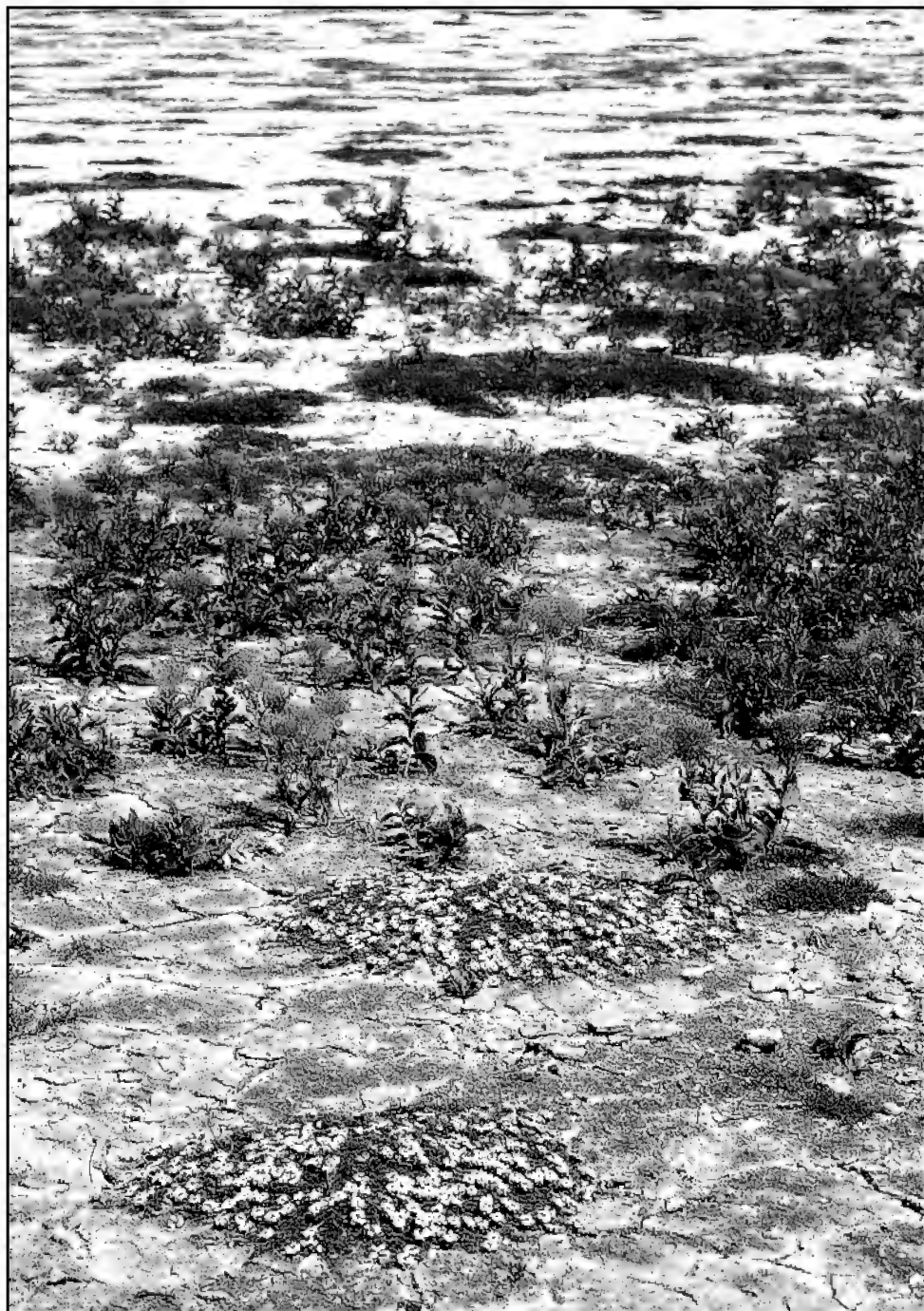


Fig. 10. A salt pan habitat of *Tropaeolum patagonicum* (F&V 10042) with accompanying flora of *Junellia micrantha* (Verbenaceae), immediate foreground, and *Cardaria draba* (Brassicaceae). Atlantic littoral, Santa Cruz Province, Argentina. January 2002.

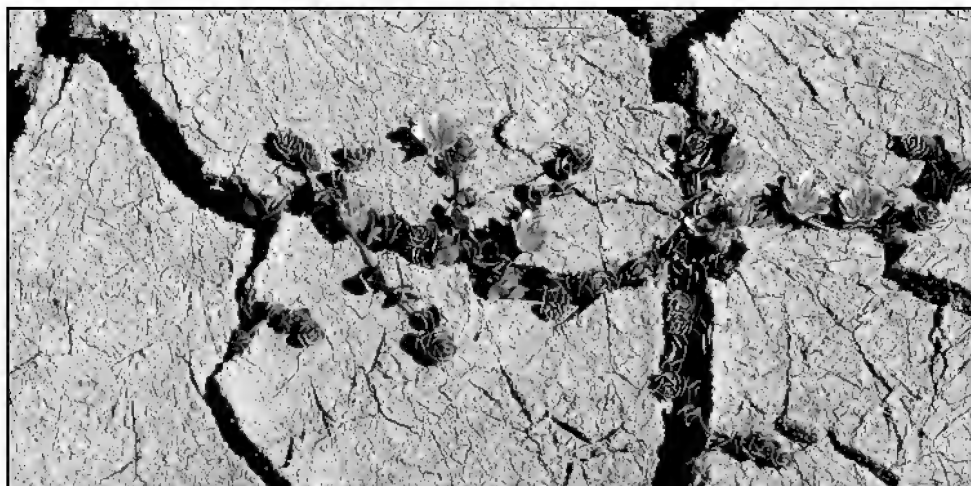


Fig. 11 *Tropaeolum patagonicum* (F&W 10170) in typical habitat of interstices between dried-out mud slabs of shallow seasonal lagoon. Parque Nacional Perito Moreno, Santa Cruz Province, Argentina. January 2002.

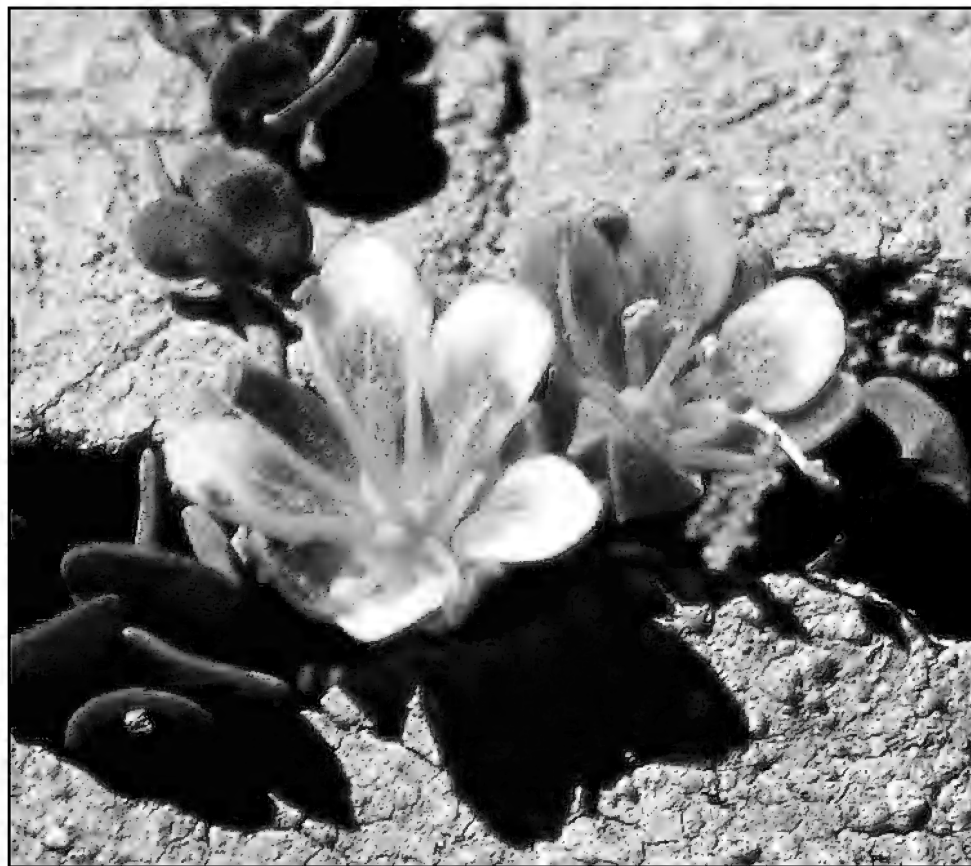


Fig. 12. *Tropaeolum patagonicum* (F&W 10170). Parque Nacional Perito Moreno, Santa Cruz Province, Argentina. January 2002.



Fig. 14 Effective beetle pollination of *Tropaeolum patagonicum* (F&W 10042). Atlantic littoral, Santa Cruz Province, Argentina. January 2002.

recessive gene however, which adds further to the fairly obvious deduction of the spur being a derived character. The hybridisation achievements of Rosemary Wilson are therefore of considerable potential systematic value, and our intention is to publish them in due course.

IV. SUBSECT. *CHILENSIA*

10. *Tropaeolum sessilifolium* Poepp. & Endl., Nov. Sp. Gen. Pl. 1:24, Tab. 38. (1835).

Type: Chile, northern sector ('Chile bor.'), mountains ('Cordillera'), Poeppig (probably) **s.n.** (lectotype: W, possible isotype: MO).

Syn.: *Trophaeum sessilifolium* (Poepp. & Endl.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Defining morphology: Rather short, slender, tuberous perennial herb. The only species with sessile to subsessile leaves and succulent, roundish, entire leaflets which also bears long-spurred (ca 15 mm) flowers. In addition corollas are visibly showy and disproportionately larger than the foliage. See the following for flower coloration details.

Distribution: Endemic to central Chile. More or less sympatric with the 400 km Chilean range of *T. polyphyllum*, q.v.

Elevations: 1900-2700 m or perhaps occasionally higher.

Habitat and ecology: Again, the very generalised Gajardo categories that have to be adopted here for practical purposes, occurrence within a mere three (G9, G11 & G12), give little idea of the subtle adaptations of this species. They indicate that it inhabits upper Andean vegetation of the Santiago and Coquimbo types, and also more xerophytic, shrubby Andean habitats from slightly lower elevations. However, within that it may at times be found standing proudly to attention in clearings of quite bare, stony soil without any prop, the only member of its not inconsiderable genus capable of performing that trick. Lazier individuals flop over rocks and boulders or sink to the ground. Most prefer the company of dwarf Andean shrublets such as *Anarthrophyllum andicola* (Gillies ex Hook. & Arn.) F. Phil. (Fabaceae) and *Viviania marifolia* Cav. (Vivianiaceae), whose low, compact statures and refined foliage offer perfect support for a tropaeolum of 12-20 cm or so.

Population status: Widespread and quite common.

Year of introduction: If not earlier, the species was introduced successfully on a small scale by Beckett, Cheese & Watson in 1972, when it certainly reached the flowering stage (K.A. Beckett, pers. comm.).

NOTE: For some inexplicable reason, many historical descriptions describe the corollas of *T. sessilifolium* as pink or violet. Even the monograph states that they are "... dark greyish yellow, often with a shade of light violet or crimson ...". In fact, although pinkish to violet coloured or apically tinged petals are encountered, white with an orange throat is the overwhelmingly predominant basic form, as most photographs and illustrations testify. This has certainly been our experience in the field.



Fig. 14. *Tropaeolum sessilifolium* (F&V 12302) in mountain steppe habitat. Lagunillas, Cordillera de Santiago, Maipo, Metropolitan Region. December 10, 2010.



Fig. 15. *Tropaeolum sessilifolium* (F&V 12302), the uncommon pink form in facultative free-standing erect posture. Lagunillas, Cordillera de Santiago, Maipo, Metropolitan Region. December 10, 2010. Photograph by A.R. Flores.

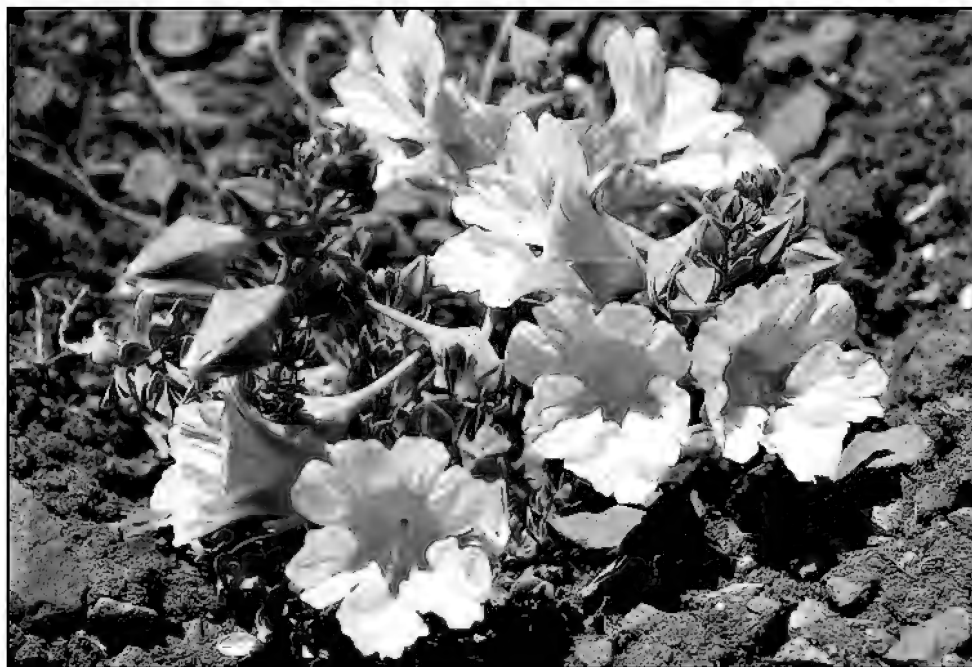


Fig. 16 *Tropaeolum sessilifolium* (F&V 12302), the predominant white form. Lagunillas, Cordillera de Santiago, Maipo, Metropolitan Region. December 10, 2010.



Fig. 17. *Tropaeolum sessilifolium* (F&V 12302), the occasional pink form. Lagunillas, Cordillera de Santiago, Maipo, Metropolitan Region. December 10, 2010.

11. *Tropaeolum x jilesii* Sparre, emend. J.M. Watson & A.R. Flores (ampl. char.), **categ. nov.** (nothosp.).

Basionym: *Tropaeolum jilesii* Sparre, Opera Bot. 108:31, (pro sp.). (1991).

Type: Chile, Coquimbo Region, Hualtata, Jiles 1172 (holotype: CONC, isotypes: LIL, S).

Emended formal circumscription*: **Highly variable**, prostrate to **scandent** perennial herb, presumed tuberous, fertile stems ca 10-**45** cm or more long, **solitary** or more or less branched, with internodes 2-**30** mm in length. Leaves **subpatent or ascending (not suberect and semi-imbricate to stem)**, peltate-lobulate, estipulate; petiole 3-**35** mm long; blade 6-**30** mm dia., subplane to crateriform, 3-5(-**6-7**)-lobed, central lobe usually clearly wider, larger in area and deeply lobed, often suborbicular, **at times not differentiated from other divisions**, these usually less divided. Flowers on peduncles 30-**60** mm long. Calyx green, yellow or greenish yellow, lobes 10-11 x 5-6 mm, equal in size and shape, triangular, apex acute, spur **very short and broadly pyramidal** to longer and slender, **2-19 mm long**, base conical (**natural spur-length variation between 2-10 mm may rarely occur on the same plants**). Petals strong yellow, the upper veined red basally, 12-**20** x 6-**10** mm, obovate-cuneate, shortly unguiculate, apex **entire** to somewhat undulate, **rarely lightly emarginate**, the lower **8-20** x 6-**8** mm, **obovate-cuneate** to suborbicular to **quadrate-truncate**, long-unguiculate with claw equal to blade or longer, apex **entire** to subrepand, **rarely lightly emarginate**. Fruits unknown.

(*Critical new emendments in bold.)

Defining morphology: Reflecting the hybrid origin discussed below and hypothesised elsewhere (Sparre & Andersson, 1991, Hershkovitz et al., 2006, Watson & Flores, 2010a), this taxon is somewhat intermediate between *T. sessilifolium* (especially in its foliage) and *T. looseri* (especially for their similar yellow flowers). However, as noted below, there should be no possibility of confusion with *T. sessilifolium*, as all *T. x jilesii* variants have lobed leaf divisions and bright yellow corollas, neither of which occurs in *T. sessilifolium*. We presume the latter taxon to be a less contributory parent from further back in biological time. On the other hand recent introgression with *T. looseri* seems likely, since some *T. x jilesii* individuals away from their natural habitat and polymorphic populations are not easy to tell apart from more compact forms of *T. looseri* when leaf lobes amount to five or more and the central one is undifferentiated.

However, one or more of the following distinctions will usually be apparent: spur less than 20 mm for *T. x jilesii*, more than 20 mm for *T. looseri*; *T. x jilesii* leaf divisions rarely more than 5, not known as more than 7, those of *T. looseri* regularly 7, not known as fewer than 5. Should these characters fail as a means of identification, it may be necessary to observe or obtain details of the wild source population as a whole, above all its variability.

Distribution: This rarity, described a decade ago, inhabits the Andean zone towards the north of Coquimbo Region above Monte Patria and also heights adjacent to the Elqui valley. Endemic to northern central Chile.

Elevation: 2600-3000 m.

Habitat and ecology: It occupies one Gajardo category (G10) as interpreted from Jiles's type field note and our experience. That is: Andean steppe as typical of Coquimbo Region, signifying generally drier and hotter conditions. Jiles describes it as spreading over the ground or clothing low bushes, exactly equivalent to our populations, where some individuals were noted climbing through low, dense bushes of *Ephedra breana* Phil. (Ephedraceae), while most simply covered bare ground or tumbled over rocks.

Population status: Marticorena et al. (2001) categorized it as insufficiently known and possibly extinct in Coquimbo. Although its overall situation is not nearly so critical since our additional discoveries, it should nevertheless continue to be regarded as very rare and localised, and possibly endangered, if even still extant at the type location. This has not been visited since the original 1949 gathering. A further factor to take into the reckoning is the extreme variability of the lower population we encountered. The importance of safeguarding populations exhibiting such genetic diversity cannot be over-emphasised.

NOTES: A problematical and potentially contentious hybrid taxon. Out of the context of their wild populations individual specimens can be difficult to differentiate and key apart from what may be presumed as the most actively involved of its generally accepted parents, *T. looseri*.

Defining populations which resemble *T. looseri* in all but the smaller dimensions of their foliar (and floral?) parts as microforms of that same species, which we consider correct, lends additional support to hybrid origin of *T. x jilesii* (see also under *T. looseri* below). One postulated

parent, *T. sessilifolium*, is a mid- to high Andean ecotype. The other, *T. looseri*, occurs at lowland to mid-Andean elevations. Its microforms are the commonest variant at the upper limit of its vertical range, and therefore the most likely to overlap and cross-pollinate with *T. sessilifolium*.

Our very recent discovery of the remarkably polymorphic range of what we now classify as *T. x jilesii* occurred between ca 2600-3000 m north of the main Elqui valley (October 2010, pers. obs.). Prior to that, the then *T. jilesii* was generally considered to occur at three locations only. Two were towards the north of Coquimbo Region (Sparre & Andersson, 1991, Hernández-Pellicer, 2003, 2005, Hershkovitz et al., 2006); the third from Alicahué in Aconcagua Province of Valparaíso Region (Zöllner & Nils, 1996).

Despite general acceptance of the latter locality (e.g., Marticorena et al., 2001, Hershkovitz et al., 2006), it must be discarded without the least doubt. We have examined both the paper recording and illustrating it and the voucher specimen on which it is based, the latter also accompanied by a high quality colour photograph. It is unmistakably *T. sessilifolium*, both for the undivided, semi-imbricated leaflets and typical flower coloration.

Hershkovitz **00-263**, a collection made in 2000 and used as the molecular sample for *T. jilesii* in Hershkovitz et al. (2006), was also collected distantly from the Jiles specimens, but in that case geographically much closer to his type locality; in Coquimbo Region near Pabellón, somewhat north of the type site. We have not yet had the opportunity to examine it directly. However, the photographic image reproduced twice and labelled *T. jilesii* in Hernández-Pellicer (2003, 2005) must have been taken at this population, since it is certainly not from the type site, the only other possibility. Hernández-Pellicer (2005) defined *T. jilesii* as differing from *T. looseri* solely by its shorter petioles, her concept otherwise pronouncing them as morphologically identical.

This is a total misunderstanding, as our examination of a scan by CONC of the *T. jilesii* type sheet clearly revealed. Its central leaf division is outstandingly larger and broader than the remaining divisions, in fact suborbicular, whereas *T. looseri* has relatively narrower lanceolate leaflets all of more or less equivalent outline. Furthermore, the *T. looseri* leaf divides as 5-9, most commonly 7 leaflets, that of the *T. jilesii* type specimen being usually 3-lobed, less often 5-lobed (Sparre & Andersson, 1991, pers. obs.). The photograph of Hershkovitz **00-263** is therefore unquestionably in fact

a microform of *T. looseri*. As a consequence of these revisions, until our own new encounter, the Hualtata type collection of Jiles remained the only accurately identified and true collection of *T. jilesii*.

Even before encountering this rare tropaeolum and redefining it as a nothospecies, we considered that the standard monograph (Sparre & Andersson, 1991) offered an unsatisfactory, even partially false concept of *T. jilesii*. Comparing its entry and drawing with the type specimen and original field notes by Jiles (pers. obs.), we found the following discrepancies. (1) The monograph indicates the type altitude as 2400 m. The field notes state 2600 m. (2) The drawing by Sparre portrays *T. jilesii* foliage as remarkably similar to that of *T. sessilifolium*. In point of fact the two are quite distinct. The petioles and three-lobed leaf blade of *T. sessilifolium* are both directed upwards and almost clasp the stem. By contrast, *T. jilesii* foliage diverges away from the stem, even on its congested basal shoots, and the blade has typically radiating lobes more or less on the same plane. Sparre's illustration of an individual leaf conveys this well enough, but his depiction of the plant does not. (3) Most critically and inaccurately, the text describes the lower petals of *T. jilesii* as long-clawed, almost round and with a repand (wavy, uneven) tip. The drawing contradicts that description, showing a more obovate form with an emarginated tip, and which clearly tapers gradually (i.e., it is cuneate) to a claw barely half its length. Careful examination of the type specimen revealed two well-exserted overlapping lower petals, which can be seen as repand and abruptly truncate to the long, stalk-like claw. Even with its base contained well within the calyx, the claw still looks as long as the blade. Although the outline of the blade cannot be discerned perfectly, it appears to be distinctly more square than round. In fact the drawing of the lower petal of *T. looseri* in the monograph looks to be equally representative of the *T. jilesii* type. Sparre and Andersson's description of *T. sessilifolium* petals as usually a shade of yellow only adds further to confusion between that species and *T. jilesii*.

The monograph suspected a hybrid origin for *T. jilesii*, which we have always accepted unconditionally; *T. looseri*, *T. sessilifolium* and *T. polyphyllum* were postulated as potential parents, the latter to account for the short spur of *T. jilesii*. In our judgement the strong general correlation between the flowers of *T. looseri* and growth form of *T. sessilifolium* and the equivalent features of *T. x jilesii* are sufficient for them to stand as

sole parents. We notice no other evidence of *T. polyphyllum* to justify parental involvement – such as general robustness, unbranched, naturally procumbent habit, or dense terminal clustering of flowers. To that might be added that *T. polyphyllum* is set well apart on the subsect. *Chilensia* clade branch of the ITS tree (HersHKovitz et al., 2006). The shorter spur length of *T. jilesii* can now readily be taken as a straightforward selective evolutionary development, as shown by the remarkable and multifarious range of spur lengths recorded recently by ourselves in the lower of the Elqui populations.

Our assessment of *T. x jilesii* as a recent and evolving nothospecies is based on observation and sampling of the newly discovered Elqui populations in conjunction with careful examination of all material collected by Jiles during his two visits to the type site. Plants at the Elqui upper altitude limit, 3000 m, are relatively uniform; dwarfish, few-flowered, their leaves closely resembling those of Jiles's original type specimen with their large, rounded, subdivided central lobe. Proportionately much larger flowers differ little from those of standard *T. looseri*, except for their somewhat shorter spur. In fact the upper Elqui population is effectively identical with Jiles's Hualtata type specimen. The lower population differs dramatically however. It too contains individuals broadly conforming with those just described, although most are taller, more vigorous in all their parts, and with a more abundant concentration of terminal flowers. Wide differences are apparent in spur lengths, from rarely 2 mm to over 15 mm, including between 2 mm and 10 mm on the same plants! Although usually containing at least a few wider lobes on some blades of any given plant, leaves can much more closely approach in increased proportions, shape and number of lobes those of *T. looseri*. The contrast of foliage between individuals in the same colony can be particularly telling, with some at the diminutive extreme of the scale having densely set foliage of less than half the maximum dimensions, the divisions often no more than three and packed into a dense, fan-like arrangement. It is simply not logical or even rational to define these co-habiting multifarious differences as one stable species rather than an evolving hybrid. Nor would any attempt to separate them out as more than one taxonomic element make sense, if even remotely possible.

Following our personal field experience, we became curious about the flowering collections Carlos Jiles had made on a return to the type site

the following season, nine three months after his first visit, where he also collected accompanying material later separated and identified as *T. looseri* (Jiles, in sched., Sparre & Andersson, 1991). Why had Sparre chosen his type from the January October rather than October January collection? We had scans of all the October January gatherings sent from CONC, where Jiles's collection is now housed. Significantly, the material mixed with his *T. jilesii* that Sparre had determined as *T. looseri* in fact aligns best with our lower Elqui *T. x jilesii* variables and not with Sparre's own circumscription of *T. looseri* (pers. obs.). Even he admitted in a memorandum dated January 1959 on the October 1949 field note of his *T. jilesii* identification when comparing it with intermixed plants he had separated off as *T. looseri*: "The two ... are rather alike, but you may compare calcar (= spur, J.W.), form of leaves and general life form." (pers. obs.). In his eagerness to demonstrate discontinuity of characters, it seems Sparre selected the individuals most distant from *T. looseri* and closest to *T. sessilifolium* for his *T. jilesii*. Ironically, the mix at the type site looks as good an indication of a nothospecies 'swarm' as ours!

T. x jilesii could be regarded as an active evolutionary hybrid equivalent in subsect. *Chilensia* to *T. x tenuirostre* in subsect. *Gracilia*.



Fig. 18. *Tropaeolum x jilesii* (Jiles 1172). Ex holotype, CONC. Hualtata, Monte Patria Province, Coquimbo Region, Chile at 2600 m. Collected January 15, 1949. Photoscan by A. Marticorena, modified by J.M.Watson.



Fig. 19 *Tropaeolum x jilesii* (F&W 12222A) as mainly prostrate on sloping, open, rocky terrain at 2600 m. Below Casarones, Elqui Province, Coquimbo Region, Chile. November 27, 2010.



Fig. 20. *Tropaeolum x jilesii* (F&W 12222A) revealing significantly variable spur length on the same plant, as observed for a few individuals of the population, and also showing the unevenly lobed leaves. Below Casarones, Elqui Province, Coquimbo Region, Chile. November 27, 2010.

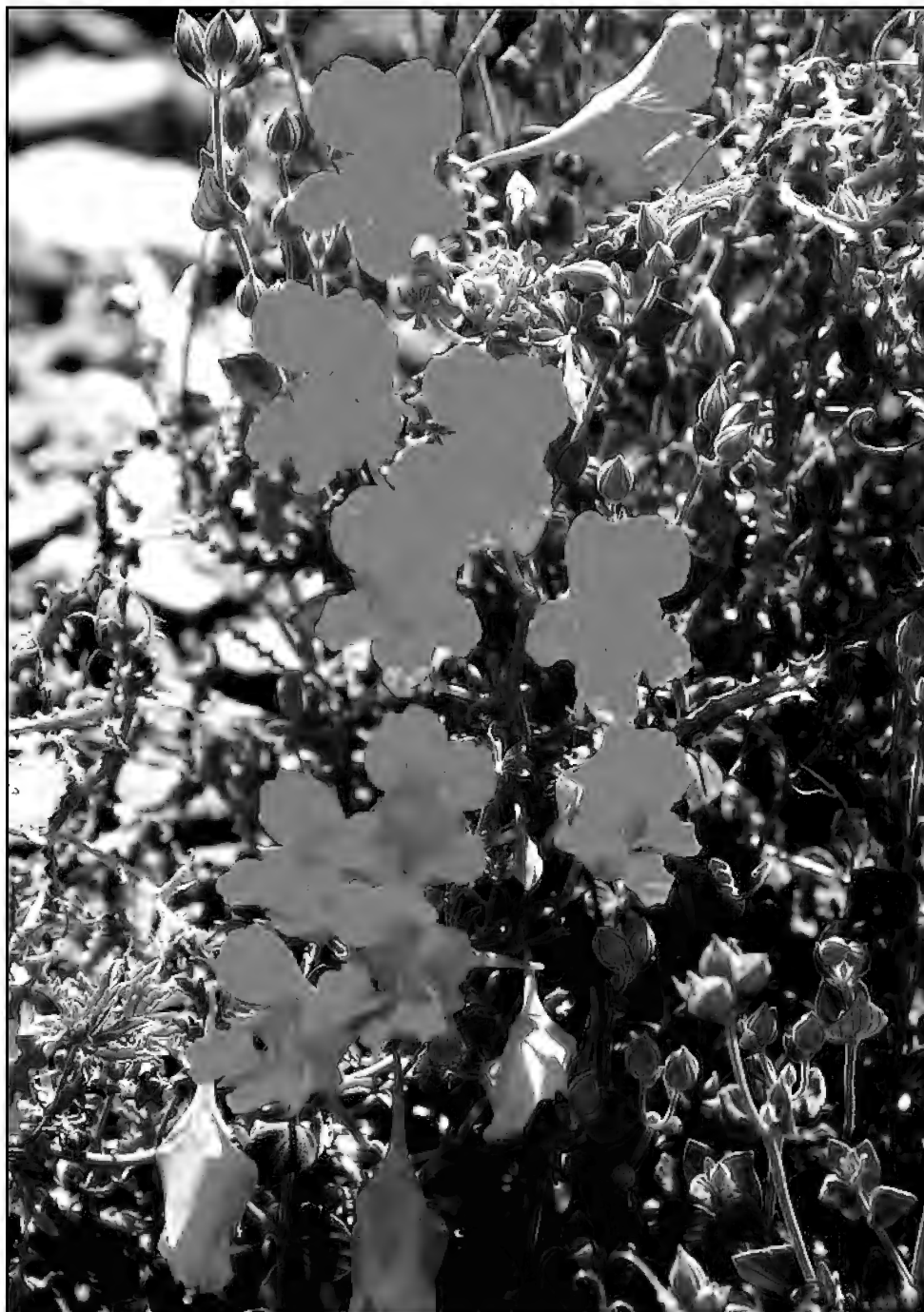


Fig. 21. *Tropaeolum x jilesii* (F&V 1222A) demonstrating its optional and perhaps preferred capacity to climb and scramble. Below Casarones, Elqui Province, Coquimbo Region, Chile. November 27, 2010.

12. *Tropaeolum looseri* Sparre, Darwiniana 11:114. (1955).

Type: Chile, Coquimbo Region, Hacienda Pangue, 1300 m, Looser **4283**
(holotype: G, isotypes: CONC, GH, SGO).

Defining morphology: Tuberous perennial. Least variable of the features we consider to encompass this species are the usually 6-7 divided lobes of its leaves and large, bright yellow, proportionately long-spurred flowers. These latter are the most typical form for the subsection. Otherwise its habit is very polymorphic when considered as population extremes. It can be relatively compact and procumbent or scrambling through low scrub on exposed upland stonefields, and by contrast quite high-climbing in lowland shrubberies. Despite this, it may always be told by the lanceolate, more or less divided lobes or leaflets, which although varying from green to silverish, are all of closely equal outline, and differ clearly from the notably broader divisions of *Tropaeolum incisum* (Speg.) Sparre and the sublinear leaflets of *Tropaeolum myriophyllum* (Poepp. & Endl.) Sparre, both far more southerly species with much denser terminal concentrations of flowers.

The greatest difficulty arises from the need to distinguish it from forms of its own hybrid *T. x jilesii* which most closely approach it in general appearance. We propose the following identifying criteria, if necessary in combination: the spur of *T. looseri* is longer, at 20 mm or over: the central leaf-lobe of *T. x jilesii* is almost invariably larger, in particular wider, than the remainder and not lanceolate, and the number of its lobes does not usually exceed six, as is often the case with *T. looseri*. Failing all that, if *T. looseri*, it will have been derived from a morphologically homogeneous population.

Another complication is presented by uniform populations which correspond to the *T. looseri* protologue of Sparre in all but the reduced size of many or most organs. We consider these variants are most logically defined as microforms within an amplified concept of *T. looseri*, rather than populations of *T. x jilesii* as considered by Hernández-Pellicer (2005) and Herschkovitz et al. (2006). Even so, the microforms and remaining range of variation within the concept of *T. looseri* as proposed by ourselves may perhaps still pose a systematic dilemma.

Distribution: An endemic of Chile, north from the central area. Very sporadic across ca 500 km between the south of Atacama Region and Aconcagua Region.

Elevations: 900-2400 m.

Habitat and ecology: This species appears to be rather limited, occurring within only three Gajardo categories (G10, G11 & G15). We have seen it in two. At greater altitudes or in more exposed conditions it grows on open, rocky terrain or in coarse stable scree with scattered low xerophyllous shrub individuals or patches, for example of *Adesmia* (Fabaceae) and *Discaria trinervis* (Gillies ex Hook. & Arn.) Reiche (Rhamnaceae). It either flops across the ground or climbs up into twiggy support. Accompanying vegetation tends to consist of dispersed, low herbs such as loasas and *Stachys grandidentata* Lindl. (Lamiaceae). However, at its upper range the vegetation will be more compact and Andean. In lower mediterranean-type hill country its stems extend to a far greater degree, reaching up through taller and rather vigorous but still well-scattered xerophyll shrubs.

Population status: Known from a few localities only at the southern end of its range, where also rather limited in numbers as observed. By contrast it is recorded as well-established at a significant spread of sites in the northern half of Coquimbo Region, and rated as unendangered there by Marticorena et al. (2001).

NOTES: The standard monograph indicates this species as procumbent or rarely climbing. As just noted, our encounters contradict this. In fact even when seen growing across the ground we would describe it as decumbent by default of support. The monograph also gives its lowest elevational occurrence as 1200 m, but it has since been found about 200 km to the south at 900 m or less, and Hernández-Pellicer (2005) records it from 800 m upwards in Coquimbo.

Together with *T. x jilesii*, it is singular among the Andean group in having as its main habitat the northerly phytoclimatic zone also inhabited by three of the more inland-dwelling of the mediterranean and Pacific clade, *Tropaeolum azureum* Bertero ex Colla, *T. kingii* and *T. tricolor*. Compared with other Andean tropaeolums, that factor inevitably makes their flowering, and above all fruiting, uniquely more or less dependent on years of heavy regional rainfall, especially as a result of El Niño, in a region where precipitation is notoriously fickle from year to year.



Fig. 22. *Tropaeolum looseri* (F&W 11740) in optional upland procumbent growth. Arqueros, Elqui Province, Coquimbo Region, Chile. October 18, 2008.

13. *Tropaeolum leptophyllum* subsp. *gracile* (Hook. & Arn.) Sparre, Opera Bot. 108:30. (1991).

Basionym: *Tropaeolum polyphyllum* Cav. var. *gracile* Hook. & Arn., Bot. Misc. 3:161. (1833).

Type: Chile, Maule Region, Linares, Cuming **839** (lectotype: BM, isotypes: E/GL, K).

Syn: *Tropaeolum gracile* (Hook. & Arn.) Sparre, Darwiniana 11:121. (1955).

Defining morphology: Robust perennial tuberous herb, procumbent or scrambling to climbing, with solitary or few stems, these almost invariably unbranched. Flowers are effectively identical in form and size with the type subspecies. However, they may be a paler shade of more creamy yellow and are often more openly dispersed along the stem. Plant growth is also usually somewhat coarser. The main differentiation is found in the leaves, those of subsp. *gracile* being notably more diminutive in petiole length (ca 20 mm) and leaflet length (to 7 mm).

Distribution: Endemic to southern central Chile for about 250 km between the Andes of Maule and the Angol district, extending to the littoral in the south of its range.

Elevations: From near the coast to 1900 m.



Fig. 23. *Tropaeolum looseri* (F&V 8598) as a lowland scrambling climber. Chacabuco Pass, Aconcagua Province, Valparaíso Region, Chile. September 1997.

Habitat and ecology: This subspecies may be found in six of Gajardo's categories (G21, G25, G26, G27, G28 & G37), together with another uncoded one added by ourselves. The additional category is as a near-ineradicable weed of lowland Chilean agriculture. It would appear to be the only member of its genus classified as a weed ... in their native lands! The Gajardo categories range from lower pure Andean but rather coarse, often low, steppic scrubby vegetation, where we have seen it making its way obliquely through short shrubs, to slightly lower-elevation xerophyllous montane scrub and various communities of open, deciduous, dry woodland.

Population status: Widespread and common.

Year of introduction: This subspecies is known in specialised cultivation, but no records have been traced by ourselves as to when it was introduced, or by whom.

NOTES: According to analyses taken from different populations (Hershkovitz et al., 2006), subsp. *gracile* was found to be polyphyletic. They report not only that their two samples diverged to a remarkable degree, but that their findings do not unite both subspecies monophyletically either. Further resolution is clearly necessary, and presumably potential resulting taxonomic revision cannot be ruled out.

T. leptophyllum subsp. *gracile* was considered by Sparre & Andersson (1991) to be a geographical variant of the type subspecies. Their distribution map for the species as a whole shows an allopatric distribution for its two taxa, with an apparent distinct separation of over 200 km. However, their own geographical specimen data and that of others indicate a definite N-S sympatric overlap in the Maule and Linares sector. Our own observation places the type subspecies as more an element of the upper mid- to moderately high Andean flora, while subsp. *gracile* appears to show a preference for lower altitudes, including not far from sea level. It is therefore possible that the two are indeed fully separated by vertical distribution. This aspect requires investigation.

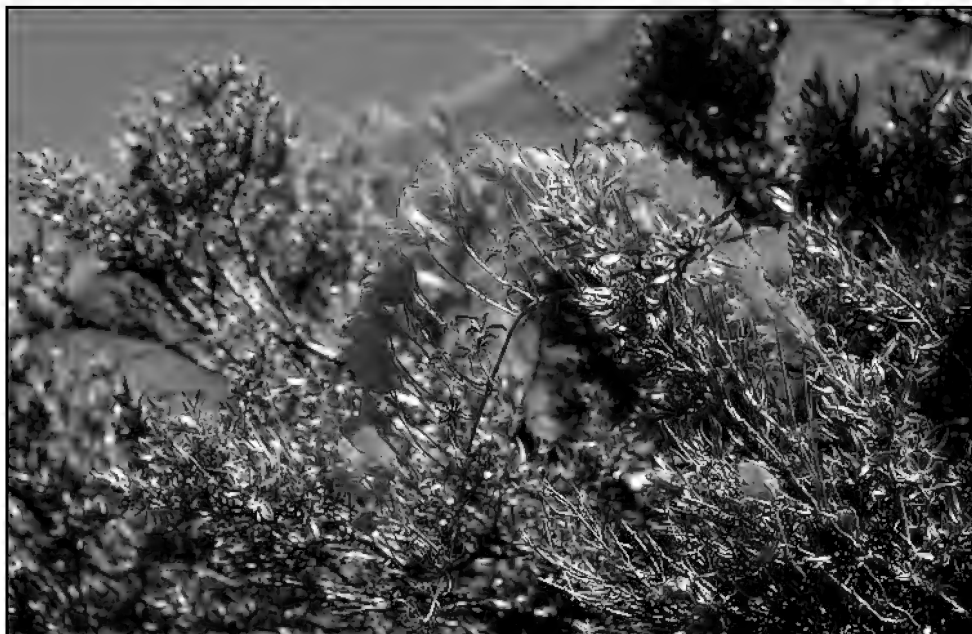


Fig. 24 *Tropaeolum leptophyllum* subsp. *gracile* (F&W 8390). High Maule river valley, Maule Region, Chile. February 1995.



Fig. 25. *Tropaeolum leptophyllum* subsp. *gracile* (F&W 7683). High Maule river valley, Maule Region, Chile. January 1993.

14. *Tropaeolum myriophyllum* (Poepp. & Endl.) Sparre, Darwiniana 11:119. (1955).

Basionym: *Tropaeolum polyphyllum* Cav. var. *myriophyllum* Poepp. & Endl., Nov. Gen. Sp. Pl. 1:23, Tab. 38. (1835).

Type: Chile, Bío-Bío Region, Volcán Antuco, Poeppig **794** (lectotype W, isotypes: BM, BR, G. L. LE, M, OXF, P, W).

Defining morphology: Tuberous, rather slender perennial herb, probably procumbent or scrambling, with few, presumably unbranched stems. Flowers closely resemble those of *T. looseri* and *T. leptophyllum* s.l., with most dimensions and variations of form of all three overlapping. Potential confusion is possible. The salient difference of *T. myriophyllum* is the combination in its linear leaflets of extremely narrow width, less than 2 mm wide, with serrated or incised margins.

Distribution: Endemic to Chile with very few records (ca 3-4) over its 170 km extension.

Elevations: Probably around and perhaps even somewhat over 2000 m.

Habitat and ecology: Unknown, but it must occupy at least one Gajardo category. Our educated guess suggests two likely possibilities (G13 & G36). The first is open high Andean steppe, the second the same with a cover of shrub patches. We know both types well personally from the locus classicus of *T. myriophyllum*, Volcán Antuco, where it would undoubtedly grow in deep, loose, gritty, blackish grey volcanic ash, either trailing down rolling, unstable flanks of the volcano, or flopping through stabilised shrubby patches, perhaps of *Orites myrtoidea* (Poepp. & Endl.) Benth. & Hook. ex Sleumer (Protaceae), *Ephedra chilensis* C. Presl (Ephedraceae), or *Berberis empetrifolia* Lam. (Berberidaceae). A similar type of small climber-cum-trailer certainly flourishes there: *Mutisia oligodon* Poepp. & Endl. (Asteraceae). It does seem almost unbelievable, however, that so conspicuous a plant as a tropaeolum has never been rediscovered since Poeppig's day in such an easily accessible and popular location. He distributed his original type collection to nine herbaria, so the colony must have been appreciable.

Population status: Unknown, but certainly rare overall, and probably locally, perhaps to the point of being vulnerable or endangered. This species requires urgent field investigation.

Year of introduction: Remarkably, *T. myriophyllum* appeared in Europe at the time of its discovery, presumably as seed brought back by Poeppig, and

was subsequently raised, flowered and well described (Otto & Dietrich, 1842), It evidently died out, and the species has not been relocated in the wild since, let alone collected for cultivation.

NOTE: *T. myriophyllum* is perhaps the most mysterious and least understood of sect. *Chilensia* in terms of its relationships. The close similarity of its flowers to those of *T. incisum* on the one hand (both share an equivalent range of spur length) and the very linear leaflets, similar to forms of *T. leptophyllum*, but divided as in *T. incisum*, suggest hybrid origin, which would be borne out by its apparent rarity. The 1991 monographers drew the same conclusion. No material was available for the DNA analyses (Hernández Pellicer, 2003, Hershkovitz et al., 2006).

15. ***Tropaeolum incisum*** (Speg.) Sparre, Darwiniana 11:6. (1955).

Basionym: *Tropaeolum polyphyllum* Cav. var. *incisum* Speg., Anales Mus. Nac. Buenos Aires 7:256. (1902).

Type: Argentina, Chubut Province, nr Tekachoi and Nafocahuella, Illin s.n. (holotype: LP).

Syn.: *Tropaeolum polyphyllum* forma *schizophyllum* H. Ross ex Neger, Anales Univ. Chile 103:51. nom. nud. (1899).

Defining morphology: Stout, vigorous, procumbent or occasionally scrambling, rather succulent tuberous herb, solitary or few-stemmed and almost invariably unbranched. Foliage often glaucous or silvery. Flowers compressed into dense terminal clusters. Differs from others of this nature by the distinctly broad lanceolate to spatulate leaflets which are always subdivided as lobulate to subpinnate.

Distribution: Mainly Argentinian Patagonia covering 1000 km between Mendoza and Chubut provinces; also Chile in the adjacent southern central upper Andes.

Elevations: 1000–3000 m.

Habitat and ecology: Four Gajardo categories encompass its occurrence in Chile (G12, G13, G32 & G 35), two types of high Andean steppe dropping down to two more for the upper fringes of scattered upper montane woodland where it blends with the alpine steppe vegetation. However the vast extent of *T. incisum* distribution is located in Argentina, particularly northern Patagonia (P41). Here it occupies various habitats, mainly open *Mulinum spinosum* (Cav.) Pers. (Apiaceae) cushion-shrublet steppe, but

also under the cover of open pine plantations and other light tree cover; dry, grassy boulder slopes; stony upper ridges; bare sandy banks; and even the shingle shores of lakes. One such exceptional, deep salmon-pink-flowered, small lakeside colony is threatened and probably being extinguished by increasing human recreational activity (pers. obs.). The species is particularly partial to growing in loose volcanic sand.

Population status: Widespread and common to abundant. Distinctive local forms near centres of population may, however, come under threat.

Year of introduction: *T. incisum* was certainly introduced towards the end of the 20th Century, if not before, and persists in specialised cultivation (Clifton, 2007a, pers. obs.).

NOTES: As also with *T. polyphyllum*, but even more so, a surprising range of flower colours and forms exist in *T. incisum*. Perhaps the most basic colour is a somewhat restrained buff-yellow, bright yellow being encountered less often and usually at its higher elevations. Other uncommon colours include shades of golden-orange and pink including dark salmon and the occasional bright or dark red. Bicolors also occur, with the apex of the petal perhaps deep pinkish or brownish orange and gradually giving way to some variation of pale yellow in the throat. Often the exterior of the flower and buds is a darker, stronger colour, adding to the contrasts and blends. Petal tips also vary between somewhat repand or emarginate to intricately divided, showing a far greater baroque tendency towards ornate wavy, slashed and scalloped edges than those of any other similar species.

Mericarps of *T. incisum* are certainly the largest in the genus. They detach freely and are smooth, almost globose and surprisingly lightweight, like lilliputian ping pong balls. There seems little doubt they have evolved the dispersal method of bowling along level Patagonian terrain propelled by fierce southern transandean winds.



Fig. 26 *Mulinum spinosum* steppe (foreground), a widespread Patagonian vegetation community, here habitat for *Tropaeolum incisum* (P&V 6293). Primeros Pinos, Neuquén Province, Argentina. January 22, 1988.



Fig. 27. *Tropaeolum incisum*, rare salmon red form (P&V 6163A), flowering on an unusual freshwater lake-shore shingle habitat. Note vehicle tracks indicative of continual threat to the small population by human leisure activity. Lago Lolog, Neuquén Province, Argentina. December 26, 1987.



Fig. 28. *Tropaeolum incisum*, rare red form (F&W 10652B). Lago Lolog, Neuquén Province, Argentina. December 29, 2002. Photograph by A.R. Flores.



Fig. 29 *Tropaeolum incisum* (F&V 11552). Near San Martín de Los Andes, Neuquén Province, Argentina. December 23, 2007.



Fig. 30. *Tropaeolum incisum* (F&V 7220). Cordillera de Talca, Maule Region, Chile, at over 2000 m. January 1993.

16. *Tropaeolum leptophyllum* G. Don, Gen. Hist. 1:747. (1831) subsp. *leptophyllum*.

Type: Chile, O'Higgins Region, Colchagua Province, Bridges or Cuming **s.n.** (neotype: NY).

- Syns: *Tropaeolum chilense* sensu Steud. non Bertero ex Colla var *eximium* Steud., Nom. Bot. ed. 2. 2:721, nom. nud., as 'eximia', sphalm. (1841).
Tropaeolum edule Bridges, London J. Bot. 1:262. (1842).
Tropaeolum bridgesii Fielding & Gardner, Sert. Pl.: Tab. 39. (1844).
Tropaeolum albiflorum Lem. & Van Houtte, Fl. Serres 3:241. (1847).
Tropaeolum popelari Drapiez, Allg. Gartenzeitung 15:161. (1847).
Tropaeolum linearifolium Steud., Flora 39(28):440. (1856).
Trophaeum bridgesii (Fielding & Gardner) Kuntze, Revis. Gen. Pl. 1:97. (1891).
Trophaeum edule (Bridges) Kuntze, Revis. Gen. Pl. 1:97. (1891).
Trophaeum leptophyllum (G. Don) Kuntze, Revis. Gen. Pl. 1:97. (1891).
Trophaeum linearifolium (Steud.) Kuntze, Revis. Gen. Pl. 1:97. (1891).
Trophaeum popelari (Drapiez) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Defining morphology: Stout, vigorous, procumbent or occasionally scandent, rather succulent tuberous herb, solitary or few-stemmed, and almost invariably unbranched. Leaves green, radial leaflets narrow, usually entire, or one very occasionally slightly divided. Flowers large and yellow, contracted into a dense terminal cluster. Differs from subsp. *gracile* by its longer petioles (30-40 mm) and leaf divisions (over 10 mm).

Distribution: Central to southern central Chile, also in Argentinian northern Patagonia. The range extends over 500-600 km between Aconcagua Region and the Epulahuén lakes of Neuquén Province.

Elevations: Perhaps as low as 1000 m to over 2500 m.

Habitat and ecology: Although only two Gajardo categories are inhabited as known to ourselves, with one additional in Patagonia as a toehold (G11, G13 & P41), they are widely variable, and there are probably more. They range from High Andean habitats through middle-mountain dry matorral scrub to interior xerophyllous hill scrub. On the one hand we have certainly mainly encountered it trailing along or down bare ground at altitude, the growth habit tight with dense, erect leaves, and ending in a spectacular apical bunched flower-burst. On the other hand we have also identified it low down in the mediterranean-type hill country scaling tallish shrubs and with an elongated looser and more open habit, including the flower

cluster. In Argentina this subspecies grows in semi-shaded part-shrub, part-mulinum steppe with scattered tree cover, but the habit is again procumbent ground-covering, as illustrated in Watson & Flores (2010a).

Population status: Widespread and common.

Year of introduction: Both Paxton & Hereman (1868) and Sparre & Andersson (1991) cite 1841 as the first indication of introduction under the synonym of *T. edule*.

NOTES: A plant collected by ourselves (Beckett, Cheese & Watson) in seed on rocky slopes well above Lago Teno in 1972 was raised at Kew and flowered in the alpine house for many years (T. Hall, pers. comm.). It was determined without doubt as *T. leptophyllum* s.s.. The terrain surrounding Lago Teno is registered at over 2500 m, which justifies our upper elevation figure.

If the altitude range of this taxon is not uncharacteristic of the Andean alliance, the extreme dimorphism apparently associated with it most certainly is to our eyes. Both *T. incisum* and *T. polyphyllum* share comparable vertical ranges with *T. leptophyllum* s.s., but neither changes character from a compact, robust, procumbent trailer to a weaker-stemmed, sparsely foliate ecotype extending to over 2 m, which thrusts up almost vertically through and over tall, supporting shrubs. In fact the two comparative species scarcely change character at all with elevation. The closest polymorphic equivalent is *T. looseri*, but that does not have densely clustered terminal flowers at altitude. As further evidence, the plant raised at Kew from our high Andean collection retained its compact, procumbent stature when grown in an alpine house in London (pers. obs.). The problem lies in the basic floral similarities or continuities of most of the Andean group, with the consequence that distinction relies heavily on foliage differences. In effect *T. leptophyllum* s.l. is the only species among them with notably narrow, entire segments, resulting in any specimen with that characteristic being inevitably so identified. It seems very likely that further and more comprehensive DNA analysis may detect a critical genetic difference between the Andean and lowland ecomorphs. The latter may in fact be more closely related to what is currently recognised as subsp. *gracile*.

Lemaire (1847) published a species as *T. albiflorum*, a white-flowered plant beautifully illustrated for him by Stroobant from a plant growing in a

famous Belgian nursery garden. This entity was discussed but not accepted in the standard monograph (Sparre & Andersson, 1991), where various anomalies were pointed out. Additionally, details of the original coloured engraving were accurately copied as line-drawings by Sparre under the synonym *T. popelari*. It was noted that no actual specimen appears to exist, and accordingly the taxon is only supported by Stroobant's artistic presentation. Nothing is known of its wild origins either, assuming it was not an artificial hybrid. As the monograph points out and illustrates, the portrayal of the spur as seen for various flowers and buds in the illustration seems to be both incompatible and ambiguous. Whereas some spurs accord with *T. leptophyllum*, others are far too short some also being stout and equipped with an appendage. We nevertheless reject the monographers' suggestion that the plant was most likely a creative artistic 'invention'. Apart from the spur, other aspects of its appearance are perfectly consistent and credible. The leaves actually match perfectly one of the types drawn for *T. leptophyllum* in the 1991 monograph. The only other doubtful feature is where some upper petals were portrayed as emarginate, others sinuous. Similar variation can sometimes be observed on living tropaeolums though, and may result from the maturing process of the flower. In any case, why should so obviously skilled and professionally accomplished an artist as Stroobant have been unable to envisage the same basic spur as seen from different angles, and have created a child-like mish-mash instead? It simply does not make sense. Is it possible the artist did not or could not complete the work for some reason, and it was finished crudely by another hand? Alternatively, the rare phenomenon of wide variation of spur length on the same plant might be the answer, as found on a few of our wild *T. x jilesii* individuals (see under that entry above). We incline to believe there must be some such logical reason, and that the plant does in fact correspond to the white form of *T. leptophyllum*, as seen by ourselves in photographs by Adriana Hoffmann. This large population was found in a side valley of the Río Teno valley at 1200 m, inland of Curicó (A.E. Hoffmann, pers. comm.). As we recall, flower colour and corolla form are identical to Stroobant's engraving. The wild plants looked much more compact, but this is to be expected if the Belgian originals were grown in a glasshouse, perhaps a heated one. We have accordingly included it in the above synonymy. However, should the white form of *T. leptophyllum* s.s. be judged in need of formal botanical



Fig. 31. *Tropaeolum leptophyllum* subsp. *leptophyllum* (F&V 8390) in semi-stable scree habitat with flowering *Schizanthus hookeri*. Upper Maule Valley, Maule Region, Chile. February 1995.



Fig. 32 *Tropaeolum leptophyllum* subsp. *leptophyllum* (F&W 11238). Paso Vergara, Curicó Province, Maule Region, Chile. March 1, 2006.



Fig. 33. *Tropaeolum leptophyllum* subsp. *leptophyllum* (F&W unnumbered). Upper Maule Valley, Maule Region, Chile. February 1995.

recognition and naming, the illustration on its own is an inadequate basis, and collection of a comparative Río Teno specimen must be regarded as obligatory. Only if the specimen and Stroobant's original plate can then be reconciled as one and the same taxon will *T. albiflorum* serve as a valid basionym, as implied by ICBN Article 37.4, since its illustration was published before 1 January 1958 (McNeill et al., 2006).

17. *Tropaeolum polyphyllum* Cav., Icon. 4:65, Tab. 365. (1797).

Type: Chile, Valparaíso Region, Aconcagua Province, Cordillera de Portillo, Née **s.n.** (lectotype: MA, isotypes: CONC, F).

Syns: *Tropaeolum prostratum* Miers, Trav. Chile 2:531, nom. nud. (1826).

Tropaeolum paniculatum Meyen, Reise Erde 1:342. nom. nud. (1834).

Tropaeolum polyphyllum var. *brevicaule* Poepp. & Endl., Nov. Gen. Sp. Pl. 1:24 (1835).

Chymocarpus polyphyllus (Cav.) Heynh., Nomencl. Bot. Hort. 1:195. (1840).

Tropaeolum floribundum Turcz., Bull. Soc. Imp. Naturalistes Moscou 31:426. (1858).

Trophaeum floribundum (Turcz.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Trophaeum polyphyllum (Cav.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Defining morphology: Differentiating *T. polyphyllum* from its nearest congeners, i.e. other prostrate upper mountain species with erect leaves and a dense terminal flower cluster, is not difficult. *T. incisum* has all of its broad, glaucous to silvery leaf divisions deeply divided, with the odd very occasional exception, while *T. polyphyllum* leaflets exhibit the exact reverse, being almost always entire (but see also Notes below). Foliage is also the most obvious distinguishing character from the type subspecies of *T. leptophyllum*, which has very narrow, bright green leaf divisions as opposed to the always somewhat glaucous to silvery and broadly lanceolate leaflets of *T. polyphyllum*. The latter's calyx spur is also at least 8 mm shorter. Comparing with *T. nubigenum*, fertile stems of *T. polyphyllum* are clearly longer and more vigorous, the petals larger, well-exserted from the calyx and seldom pure orange, but most usually some shade of yellow. The significant divergence in fruit characteristics of the two species may be appreciated by the detailed description in the *T. nubigenum* entry below.

Distribution: Central Chile and Argentina over some 400 km between southern Coquimbo Region and San Juan Province to the north, and

O'Higgins Region and the north of Mendoza Province, respectively.

Elevations: Ca. 2000-3000 m (very rarely more).

Habitat and ecology: The single Gajardo category given for this well-known plant in Chile and adjacent Argentina (G12), high Andean steppe of the Santiago floral type, is highly deceptive. It belies the catholic range of specific habitats within that category. The species may be found either as solitary monocultures, or consorting with the likes of *Alstroemeria spathulata* K. Presl (Alstroemeriaceae) and *Schizanthus hookeri* Gillies ex J. Graham (Solanaceae) on the mighty, restlessly shifting talus runs above Juncal. It can paint finer, more stable screes with an unbroken wash of yellow when occurring by the tens of thousands. An alternative home is the deep, stony ballast-beds of the abandoned transandean railway track, as though seeking a comfortable raised bed in an alpine garden, and then spilling down the trackside banks. It luxuriously carpets bare, soily steppe flats below mighty Mount Aconcagua with a rich pile of silvery green foliage and lemon yellow floral decorations. In the Maipo valley it takes to the stony and rocky shores of a reservoir.

Population status: Widespread and common, often super-abundant.

Year of introduction: Although Sparre & Andersson (1991) supposed that the species entered cultivation around 1840, they found no records to support this. Nevertheless, Paxton & Hereman (1868) indicate 1827 as the date of first flowering in Britain.

NOTES: This species is considerably more variable in certain aspects of morphology, not least flower colour, than is generally realised, even if not so consistently and extremely as *T. incisum*. Bright yellow is most usually encountered in the wild and perhaps exclusively in cultivation. However, it may frequently be met as large monochromatic populations, all with very pale lemon corollas, and less commonly partly or entirely orange. Occasional individuals or small groups occur which are true red. Petals also vary somewhat in shape and may at times have laciniate tips. In addition one or two leaf segments are sometimes lobed, which may or may not denote introgression with *T. incisum*. A bright red individual found at altitude south of Santiago near the volcano Maipo close to the border with Argentina (A.E. Hoffmann, pers. comm.) was illustrated as Fig. 1, p.117 in Hoffmann et al. (1998), where misidentified as *T. incisum*. This unfortunate error was due to the lobulate incisions of one or two of the



Fig. 34. *Tropaeolum polyphyllum* (F&W 12387) flowering en masse in its most typical towering scree habitat. Upper Aconcagua river valley, Juncal, Valparaíso Region, Chile. January 1, 2011.



Fig. 35. *Tropaeolum polyphyllum* (F&V 12387) as dominant and an almost ecological isolate in its scree habitat. Note the variety of colour forms, exemplified by restrained evening light. Upper Aconcagua river valley, Juncal, Valparaíso Region, Chile. December 25, 2010.

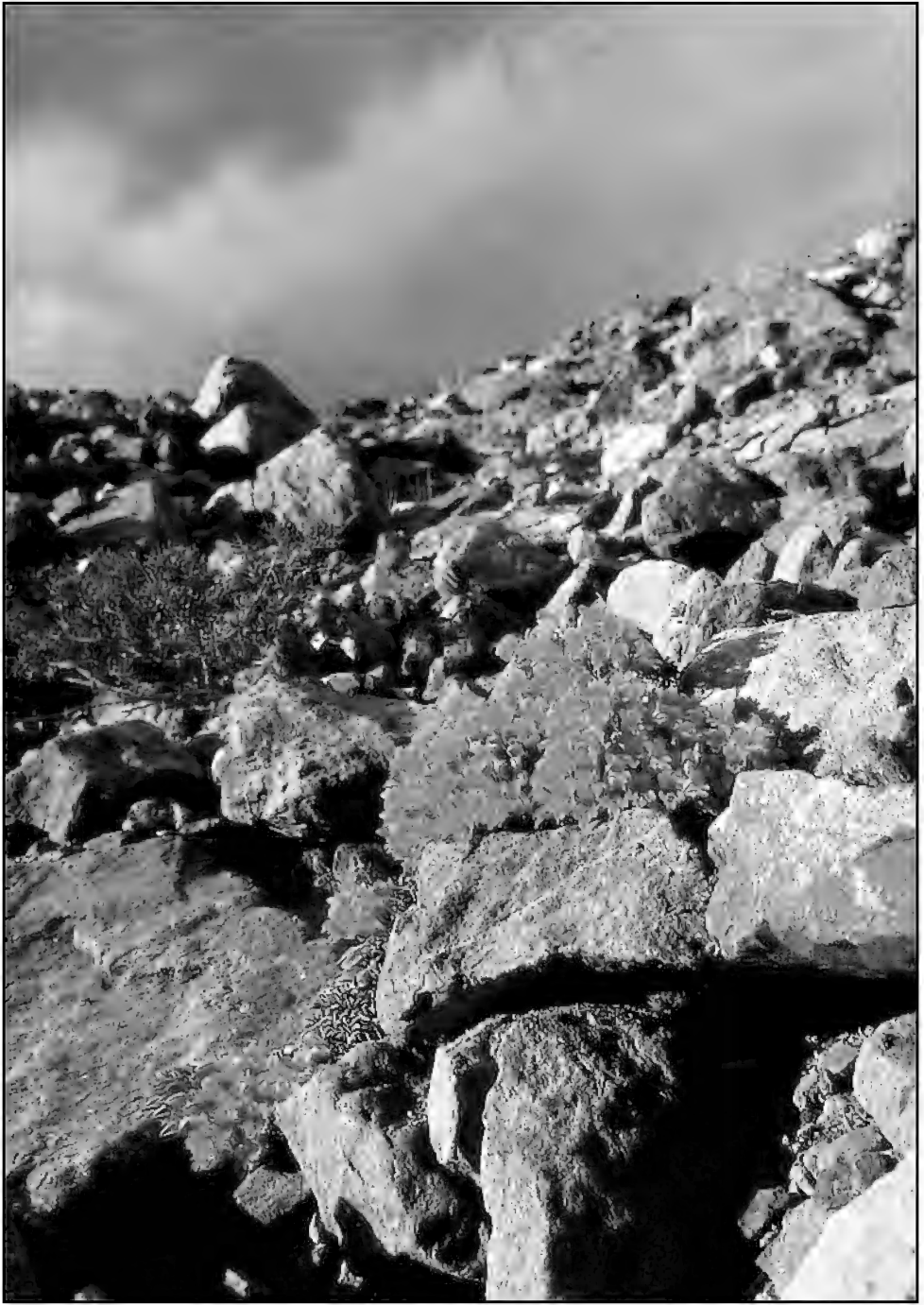


Fig. 36. *Tropaeolum polyphyllum* (BC&V 4528), a dramatic in habitat portrait. Juncal, Aconcagua Province, Valparaíso Region, Chile. December 11, 1971.

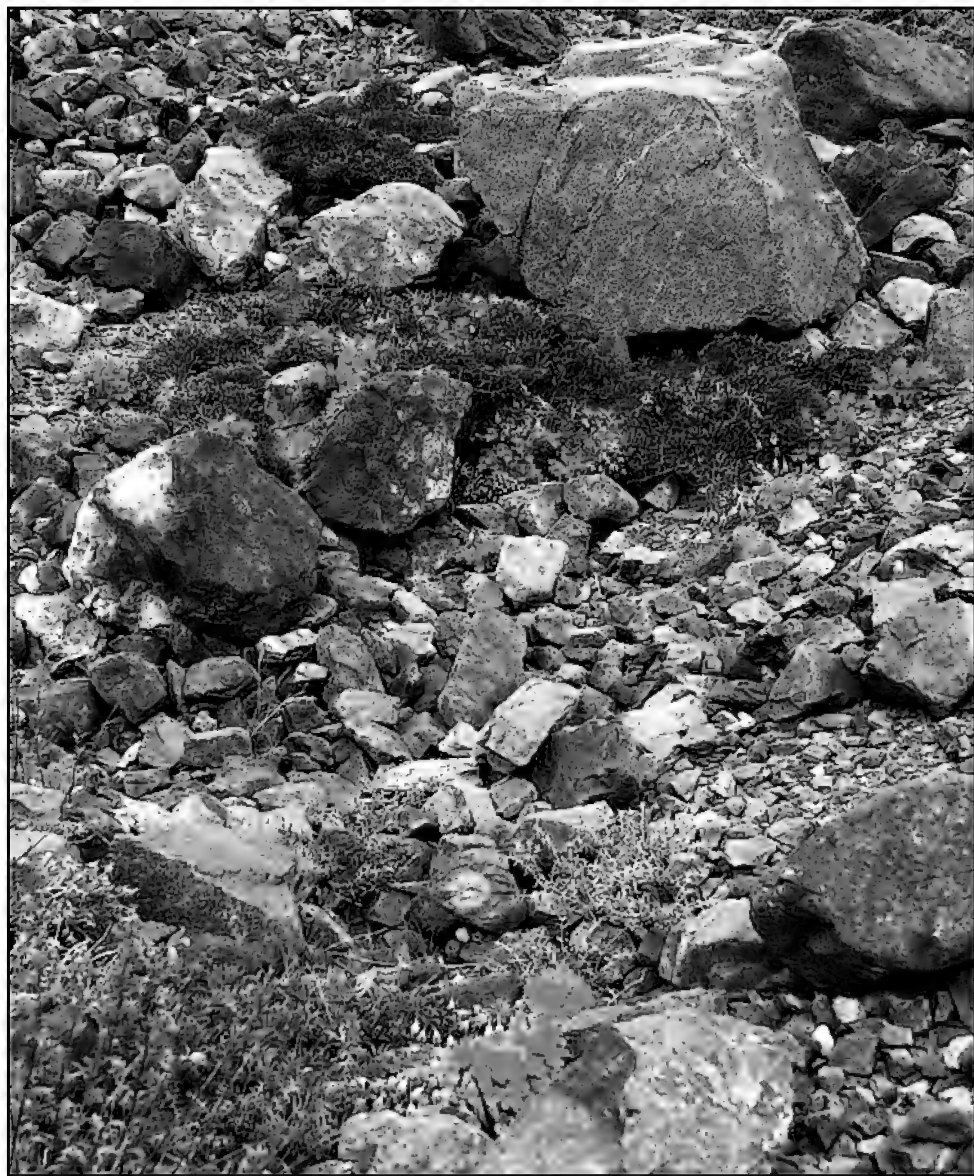


Fig. 37. *Tropaeolum polyphyllum*, rare red form (F&W 12386). An individual of the small red colony contrasted by an adjacent more usual colour form. Juncal, Aconcagua Province, Valparaíso Region, Chile. December 25, 2010.



Fig. 38 *Tropaeolum polyphyllum* (JV unnumbered) displaying along the now-disused transandean railway track near the border between Chile and Argentina. Recorded during an Alpine Garden Society tour. Portillo, Aconcagua Province, Valparaiso Region, Chile. January 16, 1991.



Fig. 39. *Tropaeolum polyphyllum* (BC&VW 4835), its best known and by far most frequently encountered colour form. Yeso Valley, Metropolitan (Santiago) Region, Chile. January 9, 1972.

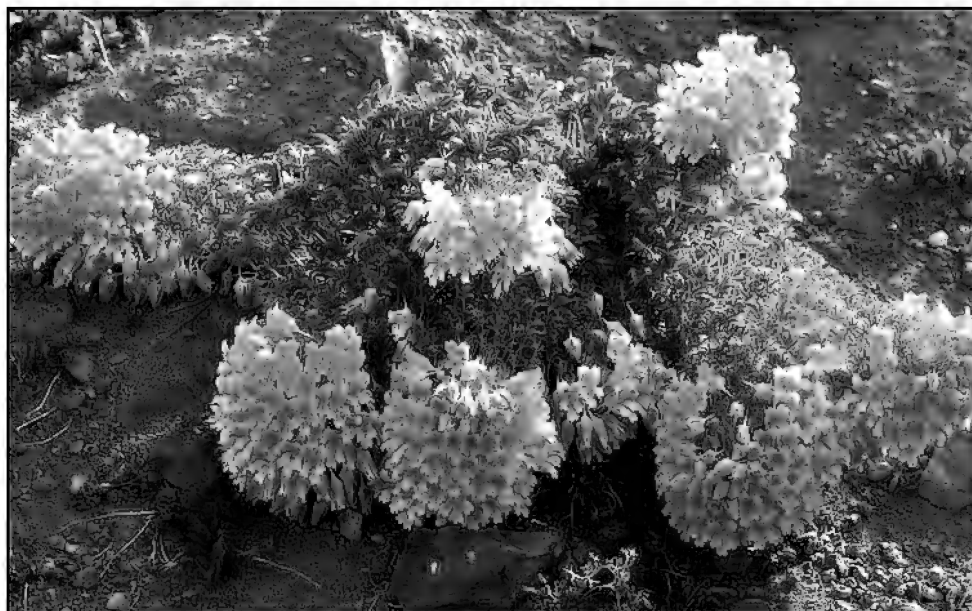


Fig. 40 *Tropaeolum polyphyllum*, pale lemon form (F&W 7670). Below Mount Aconcagua, Mendoza Province, Argentina. January 3, 2003.

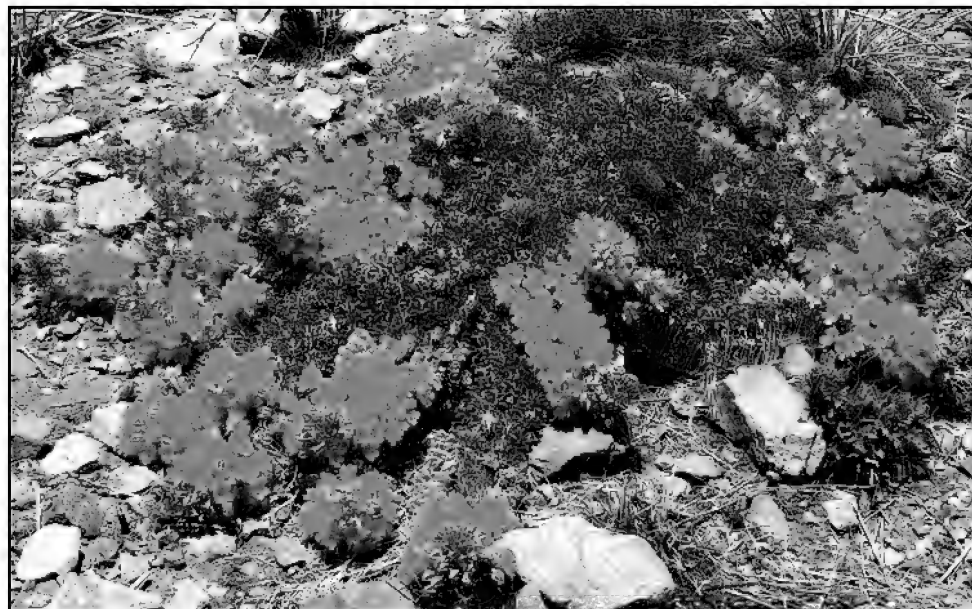


Fig. 41. *Tropaeolum polyphyllum*, orange form (F&W 12384A). This magnificent individual's portrait was shot between Juncal and Portillo, Aconcagua Province, Valparaiso Region, Chile. January 1, 2011.



Fig. 42. *Tropaeolum polyphyllum*, red form (F&W 12386). Juncal, Aconcagua Province, Valparaíso Region, Chile. December 25, 2010. Photograph by A.R. Flores.

largest divisions of some mature leaves. Sparre & Andersson (1991) specify this as an occasional morphological variation of *T. polyphyllum*. It might perhaps warrant taxonomic recognition as a form.

Arroyo et al. (1982, 1983) conducted an investigation of pollination syndromes in the high central temperate Andes. They registered bees exclusively (mellitophily) when recording visits to predominantly yellow-flowered *T. polyphyllum* from 2000 to 3000 m between Juncal and Portillo. Interestingly, we have casually recorded hummingbird visits on four separate occasions in the same sector. These agile little birds dart restlessly here and there in fast and elusive flight, so are difficult to determine with certainty, although we have assumed them to be the white-sided hillstar, *Oreotrochilus leucopleurus* Gould. However, the most recent sighting occurred coincidentally with the finishing touches being put to this text. It was a truly close encounter, providing infallible identification. One of us (Watson) was preparing to photograph a group of tropeolums in their scree habitat when a fairly small, olive grey hummingbird with a white breast and curved bill suddenly appeared and hovered, feeding from one of the flowers scarcely more than a metre away. At the very instant it had been brought feverishly into focus and was about to be snapped, it reversed and shot away, simultaneously flashing its (his) glistening electric-emerald gorget, presumably the hummingbird equivalent of thumbing the nose! Our supposition of the white-sided hillstar (Martínez & Gonzáles, 2004) was well and truly confirmed. Lower down we found an almost entirely pure red *T. polyphyllum* and speculated on the possibility of the hummers co-evolving an all-scarlet, prostrate Andean tropeolum species over future biological millenia.

18. *Tropeolum nubigenum* Phil., Linnaea 33:34. (1864).

Type: Chile, Metropolitan (Santiago) Region, Laguna de los Piuquenes, Landbeck s.n. (holotype: SGO).

Syn.: *Trophaeum nubigenum* (Phil.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Defining morphology: (See the discussion in the following Notes.)

Distribution: Central Chilean endemic. Its known occurrence as a pure species is restricted to a single extension with boundaries of no more than 5 km at the Valle Nevado ski centre in the Cordillera de Santiago.

Elevations: Ca 3000-4000 m.

Habitat and ecology: Its solitary Gajardo category (G12), that of high

Andean steppe of the Santiago cordilleran type, gives no idea of its adaptation to hostile climatic extremes of greater altitudes than are achieved by any others in its genus. Although sometimes found on boulder-strewn soil slopes, this high alpine ecotype with its all-round reduced morphology is far more frequently encountered on deep, stony scree slopes or talus beds, to which it seems closely adapted. Much flora at the same altitudes also consists of high subnival Andean chamaephytes, which are seldom if ever found below 3000 m in the region: e.g. *Azorella madreporica* Clos (Apiaceae), *Calandrinia caespitosa* Gillies ex Arn. (Portulacaceae), *Chaetanthera renifolia* (J. Rémy) Cabrera (Asteraceae), *Nassauvia pinnigera* D. Don (Asteraceae), *Nototriche compacta* (A. Gray) A.W. Hill (Malvaceae), *Viola atropurpurea* Leyb. and *V. montagnei* Gay (Violaceae).

Population status: Locally common, forming a series of discrete colonies over its restricted and highly localised total range. Nevertheless vulnerable, due to being within the bounds of a major winter sports development above the capital, which also serves for public recreation during the growing season. Such facilities are likely to expand.

Year of introduction: Seed samples provided by ourselves (Pern & Watson, Flores & Watson) were distributed during the 1990s. But although plants were raised which remained extremely compact like the wild population, flowers (two) are known to have been produced only once, in 2008, by Steven McFarlane (2009); that plant and any other resulting stock lacked vigour and apparently have all eventually died out.

NOTES: ‘More notorious than important are R.A. Philippi’s contributions from Chile’ (to the taxonomy of *Tropaeolum*), stated Sparre (Sparre & Andersson, 1991), implicitly including *T. nubigenum*. For some reason best known to himself, Sparre was inclined to disparage this remarkable, talented, industrious, and highly regarded, pioneering Chilean 19th Century immigrant-botanist and general natural history explorer of German origin.

Taking into account relevant authoritative works since it was first published, *Tropaeolum nubigenum* has largely been placed in synonymy with *T. polyphyllum* of late, either implicitly (Marticorena & Quezada, 1985, Hernandez-Pellicer, 2003, 2005, Hershkovitz et al., 2006), or explicitly (Sparre & Andersson, 1991, Zuloaga et al., 2008). However, it was earlier recognised by Reiche (1896a, 1896b) and well keyed apart from *T. polyphyllum* by him as having petals scarcely longer than sepals.

In the same treatment he also cited the Tropaeolaceae authority Buchenau as recognizing *T. nubigenum*. Our own rehabilitation of the species (Hoffmann et al., 1998) has resulted in one recent popular printed floristic work recognising *T. nubigenum* (Huyghe & Wenborne, 2003), while another has not (Riedemann et al., 2008). The Internet also offers us some additional positive support (Martinich, 2007, Belov, 2010). In truth though, whether scientific or popular, authors overwhelmingly continue to follow Sparre & Andersson's lead. No serious modern authority has yet openly accepted our judgement.

In that context it is interesting to note that whereas Sparre and Andersson (1991) cite a total of 130 specimens of *T. polyphyllum* examined during preparation of their monograph, only **one** of those originated for certain from the Santiago Region! This beggars belief, not least considering the following assessment by Navas (1976) of the species in the immediate vicinity of Santiago city alone: 'Frequent: ... San Francisco de Las Condes, Quebrada de Peñalolen, Cajón del Maipo, etc.' So was that solitary representative Philippi's *T. nubigenum* type? And how much credence should be given to their synonymising of it on this evidence? Without any doubt, Sparre never saw the Valle Nevado populations in situ, let alone made comparative field studies.

Immediately obvious characters of *T. nubigenum* are very compact, often cushion-forming habit; near-equal length of petals and sepals; notably narrow petals; deep, rich orange corolla coloration with omnipresent, distinctive, parallel blood-red guide lines on the upper petals; and the silvery-glaucous sheen of the foliage (e.g., Hoffmann et al., 1998:115, Fig. 4, Huyghe & Wenborne, 2003:148-149, Watson & Flores, 2010a:214, Fig. 19)*. Just as striking is the unvarying uniformity of these features throughout all colonies observed over its entire recorded distribution. Such morphological consistency is unknown to ourselves for its close allies. It also qualifies as a specialised ecotype inhabiting a higher and separate altitudinal range (3000-4000 m) from surrounding *T. polyphyllum*, which we have never found much above 3000 m. Subnival

*The extreme shortness of the petals and typical narrowish form of the *T. nubigenum* flower at full anthesis – almost retained within the calyx – has been subject to questioning (Clifton, 2008a). We therefore consider it essential to point out that all three published illustrations cited here are accurate portrayals of the species in full flower. Clifton and his correspondent, Megarry, also confused a low altitude reddish-orange form of *T. polyphyllum* with *T. nubigenum* (Clifton & Megarry, 2008).

elevations near the upper limit of flowering plants in the central temperate Andes present extreme environmental stress factors such as a prolonged period under winter snow, a short growing season with colder average daily temperatures, high levels of ultra-violet radiation, and a reduction and change in pollinators (Arroyo et al., 1982, 1983).

Later familiarity with *T. nubigenum* in fruit revealed further fundamental differences between it and *T. polyphyllum*. These suggest critically significant dispersal mechanisms. Mericarp size is notably and consistently smaller in *T. nubigenum*, the diameter being three quarters that of *T. polyphyllum* fruit, and the volume approximately half. 'The size of mericarps appears to be a good specific character in some cases' (Sparre & Andersson, 1991). The difference is not limited solely to size however. Dry and even still green mericarps of *T. polyphyllum* are strongly deciduous, detaching very readily from their open calyx. Those of *T. nubigenum* adhere strongly to their point of attachment at full maturity, and are usually clasped within the calyx after the plant has desiccated. They may remain so even when the aerial part separates entirely from its root anchorage. Our hypothesis for this intriguing development is based on the premise that *T. nubigenum* lacks a sufficiently long growing period to develop fruits equivalent in size to those of *T. polyphyllum*. As a partial consequence, and also in response to its environment, we speculate *T. nubigenum* has evolved an alternative 'tumbleweed' dispersal syndrome, which may equally result in germination within the existing colony or wind removal of the loose plant over longer distances. By contrast dry and even sub-ripe green mericarps detach very readily from the patent calyx of *T. polyphyllum*, and are probably mainly scattered by such agencies as wind-propulsion, surface water flow and gravity, in particular over open, reasonably even surfaces.

When occurring in the same sector, *T. nubigenum* and *T. polyphyllum* have been found to be completely allopatric with respect to altitude. A very small colony of *T. polyphyllum* exists near the ski village of La Parva, well below the main *T. nubigenum* populations, where nevertheless one possible hybrid has been noted and photographed (pers. obs.). In Aconcagua province at rather over 3000 m just to the south and slightly above the western, Chilean, mouth of the main road pass tunnel to Argentina, we have discovered what is undoubtedly a quite large hybrid swarm of *T. nubigenum* x *T. polyphyllum*. Apparently no pure *T. nubigenum* is present

in the locality, but extremes of variation are almost exact morphological equivalents of both parents. We therefore deduce *T. nubigenum* may be (or have been) narrowly and intermittently distributed along the high, almost continuous 60 km stretch of Chilean territory at 3000–4000 m between the upper Río Aconcagua valley to the north and the Río Colorado gorge in the south, which is now its only known location.

Attempting to place Landbeck's type gathering (Muñoz, 1960) within this geographical area, we ran into immediate problems. Philippi's voucher note states: "In the Andes of the province of Santiago, by the Los Piuquenes lake, at 3658–3962 m". The recognised Los Piuquenes lake, as also cited in the Muñoz (1960) gazetteer appendix of Philippi's type localities, is situated to the south of the Río Colorado gorge, 30 km from the nearest known *T. nubigenum*, and at only 2782 m. Furthermore, it lies adjacent to an extremely well floristically studied area, where only *T. polyphyllum* is known in considerable quantity, at between 2200–3400 m (Teillier et al., 1994). By good fortune this discrepancy was eventually resolved by an historical gazetteer. A second, much smaller, Los Piuquenes mountain lake, little more than a large pond, exists at the altitude stated for the type. It is situated about 5 km east of La Parva and Valle Nevado towards the border with Argentina.

Support for authoritative acceptance of *T. nubigenum* comes from further scientific sources. As a non-dissenting co-author, the highly respected ecologist, Dr. Mary Kalin Arroyo, certainly approved it as a distinct species in Hoffmann et al. (1998). Earlier, she had led an investigation of pollination mechanisms in the Andean zone of the temperate Andes (Arroyo et al., 1982, 1983). One aspect of the study questioned whether changes of pollinators at different altitudes influenced evolution of the Andean flora. Their observations included clear yellow-flowered *T. polyphyllum* between 2000–3000 m, which they found to be exclusively visited by bees (mellitophily) (but see our Notes for the *T. polyphyllum* entry above). This was compared with pollinators for what was identified as the same species above 3000 m, but with orange flowers (recognised here as *T. nubigenum*). They note hymenopteran densities diminish with altitude compared with other insect pollinators. So these plants were found to be visited as much by butterflies as bees. This was considered indicative of transition from mellitophily to psicophily (lepidopteran pollination). Although they made no mention of

hummingbirds as pollination vectors for any of these Andean tropaeolums, we have also observed a white-sided hillstar, *Oreotrochilus leucopleurus*, taking nectar from a solitary, isolated plant of *Caiophora coronata* (Gillies ex Arn.) Hool. & Arn. (Loasaceae) in the immediate vicinity of a very large colony of *T. nubigenum* at around 3400 m.

Further support for taxonomic separation of *T. nubigenum* from *T. polyphyllum* looks to be present in the sect. *Chilensia* ITS tree (Hershkovitz et al., 2006). One DNA sample was collected low down to the south of Santiago, typically where *T. polyphyllum* occurs, the other at Valle Nevado, where only *T. nubigenum* is found. They are separated from one another on the clade-tree by a short branch, with *T. nubigenum* as the more developed.

As stated above, in cultivation *T. nubigenum* retains its dwarf, compact habit, providing undeniable support for its genotypical status. In total opposition to *T. polyphyllum* it has also proved extremely intractable to manage, even for the most skilled experts, and to our knowledge has only been flowered once (McFarlane, 2009), after which overdemanding effort it promptly expired!

We do not consider the putative *T. nubigenum* x *T. polyphyllum* hybrid swarm at the tunnel of the Portillo (Caracoles) pass represents any obstacle to the recognition of *T. nubigenum*. Natural and artificial crossing between many sect. *Chilensia* taxa is a regular and well documented phenomenon. Foremost is *T. x tenuirostre*, equally heteromorphic but recognised without exception as a nothospecies.

We sum up with a list of the discontinuities, together with dominant and stable, consistent features, which characterise this element. In our judgement, when these are considered in combination they not only fully justify its acceptance at full species rank, but even indicate it as more distinct than some other taxa in the section. (Any discontinuity comparisons which follow are explicitly or implicitly with *T. polyphyllum*):

- 01) Allopatric vertical altitudinal separation (discontinuous).
- 02) Horizontal geographical isolation (almost discontinuous).
- 03) Dwarf, compact habit (discontinuous except for putative natural hybrids).
- 04) Confirmed genotypical status due to full maintenance of dwarf habit in lowland cultivation (discontinuous except for putative natural hybrids).

- 05) Unvaryingly uniform facies of all known individuals with respect to: stature; leaf form and texture; calyx, spur and petal form and colour; petal venation; mericarp size and adherence (discontinuous).
- 06) Small, narrow petals almost contained within calyx (possibly discontinuous, at least except for putative natural hybrids).
- 07) Consistent rich orange petal colour with extensive bright red venation (discontinuous as known).
- 08) Mature mericarps ca half volume of *T. polyphyllum* mericarps (discontinuous).
- 09) Mature mericarps enclosed within calyx and adhering strongly to parent plant, including after its dessication (discontinuous).
- 10) Separated from *T. polyphyllum* on the ITS DNA clade tree of Hershkovitz et al. (2006).
- 11) Early stages of pollinator differentiation from mellitophily to psychophily (this discontinuity is incomplete but developing strongly).



Fig. 43 *Tropaeolum nubigenum* (F&W 8496). Note the clear difference in size-ratio between flowers and foliage of *T. nubigenum*, an ecological microform, and all *T. polyphyllum* plants, despite the superficial similarity of relatively short and narrow petals seen in the red form of the latter as depicted in Fig. 43. Valle Nevado, Cordillera de Santiago, Metropolitan Region at 3200 m. March 1995.

V. SUBSECT. GRACILIA

19. *Tropaeolum azureum* Bertero ex Colla, Nuovo Gion. Lett. Sci. 24:147. (1832).

Type: Chile, Valparaiso Region, by the border of the Calala Pass, Bertero 1369. (lectotype: FI, isotypes: BM, CONC, G, GH, LE, NY, P, W).

Syns: *Rixea azurea* (Bertero ex Colla) C. Morren, Ann. Soc. Roy. Agric. Bot. Gand 1:225. (1845).

Tropaeolum violiflorum A. Dietr., Allg. Gartenzeitung 13:130. (1845).

Tropaeolum azureum var. *grandiflorum* Van Houtte, Pl. Serres 11:177. (1856).

Tropaeolum aureum Müll.Stuttg., Ann. Bot. Syst. 7:493, sphalm. (1868).

Trophaeum aureum (Müll.Stuttg.) Kuntze, Revis. Gen. Pl. 1:97, sphalm. (1891).

Trophaeum azureum (Bertero ex Colla) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Trophaeum violiflorum (A. Dietr.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Tropaeolum azureum var. *angustilobum* Buchenau, Pflanzenr. 4, Fam. 131:32. (1902).

Tropaeolum azureum var. *oblongilobum* Buchenau, Pflanzenr. 4, Fam. 131:32. (1902).

19a. *Tropaeolum lepidum** Phil. ex Buchenau, Bot. Jahrb. Syst. 15(2):241, 247. (1892).

Type: Chile, Coquimbo Region, Combarbalá, Geisse s.n. (lectotype: SGO, isotype, SGO).

*This potential polyphyletic geographical variant is discussed in the following Notes.

Defining morphology: Slender, delicate, multi-branched, twining, vine with tendrilloid petioles. Usually perennial, the very deep-set tuber known to exceed 2 m of depth in the ground (pers. obs.)! However, tentative evidence from cultivation suggests that first-year flowering plants may behave as facultative annuals under drought stress (see Notes below). In flower, whatever its variation, this species cannot be confused with any other. The tone of pale violet blue, to deep indigo, almost invariably white-centred corollas is unique. It is also coupled with a rather vestigial spur of only 2-4 mm. Occasional albino, or white, pinkish-tinged forms invariably occur in the wild mixed in with large populations of the typical colour range. See

following Notes for further details of colour variation.

Distribution: Endemic to northern and central Chile. One historic record from Antofagasta Region has not subsequently been confirmed. Other than that its range is fairly continuous over almost 600 km between Domeyko in Atacama Region and Santiago.

Elevations: From below 100 m to around 1200 m.

Habitat and ecology: Unsurprisingly for one of the most common and widespread species, no fewer than twelve of Gajardo's categories are occupied (G5, G6, G8, G10, G11, G14, G15, G16, G17, G18, G19 & G21). They range through xerophyllous littoral hill scrub, precordillera shrubberies and acacia savannah to open, dry woodland of the mediterranean-climate coastal mountains. Given a season of sufficient annual winter rainfall it grows freely on the hills and low passes around our Chilean home. We see it undulating over a wide variety of low and high shrubs and small trees, or tumbling down bare banks, or threading through tall grasses. Always a delight.

Population status: Widespread and common.

Year of introduction: Bridges (1842) and also Paxton and Hereman (1868) are agreed on 1842.

NOTES: Accumulated casual comments over time from horticultural sources have indicated a possible triple discrete heterogeneous growth pattern in *T. azureum* plants raised from seed gathered within the same wild populations. Even when given apparently identical cultivation by one cultivator, some individuals have flowered, set viable seed and died without forming tubers. Others have formed tubers which then remain stubbornly dormant for years, regardless of all attempts to bring them into growth. A third group makes tubers, but grows and flowers regularly without difficulty. *Cruckshanksia tripartita* Phil. (Rubiaceae) – considered synonymous with *Cruckshanksia pumila* Clos by Taylor (2008) – inhabits the same regions and experiences identical stressful and unpredictable desert and extreme mediterranean climatic conditions. Riccardi & Quezada (1963) reported its populations as dimorphic within themselves, producing a mixture of weak annuals and robust perennials. Our knowledge of the region suggests this may be an evolved survival strategy, with the dimorphism innate to seed production of both types. When humid conditions triggering ephemeral early germination, flowering and fruiting

fail to last sufficiently to sustain perennial growth, advantage lies with the annual form. By contrast a prolonged favourable season will offer at least equal benefits to the perennial form, and its continuing physical presence will help to exclude competitors for space and produce a greater abundance of flowers and seed per plant over time. It may be that trimorphism has evolved in *T. azureum* and perhaps others of mediterranean and desert subsect. *Gracilia* for similar reasons.

The recent DNA studies of Hershkovitz et al. (2006) revealed polyphyly in *T. azureum*, dividing it genetically into distinct and apparently discrete southern and northern populations. It was noted that *Tropaeolum lepidum* Phil. from the northern group was described on the basis of long, almost linear leaf segments and minor flower variations. In recent times *T. lepidum* has been regarded as a synonym for *T. azureum* (e.g., Sparre & Andersson, 1991), but the possibility was raised by Hershkvitz and his colleagues of it being rehabilitated on the strength of the DNA results. We have studied and photographed at the type site of *T. lepidum* (as formally detailed separately above) ourselves. Another feature is its strikingly dark flower coloration with a strongly contrasted white centre. However, we have observed much heterogeneity in more southern populations near our home in Aconcagua Region. These include occasional forms with long and narrow leaf segments and also very dark flower coloration with similarly contrasting centres.

‘Almost all material cultivated belonged to the more luxuriant “*T. violaeiflorum*” morphotype, with larger petals. This must be regarded as a garden modification. Also the more peculiar var. *grandiflorum* belongs here (i.e., as a product of cultivation – J.M.W.), having very large flowers and isomorphic petals, more than twice the length of the calyx lobes and almost white at the base, all according to van Houtte’s illustration (1856: Tab. 1160)’ (Sparre & Andersson, 1991). We have not seen the illustration referred to, but presume Sparre’s drawing of “*T. violaeiflorum*” (op. cit., Fig. 21P) is based on it, and the written description he provides of var. *grandiflorum* is unambiguous. Anyone familiar enough with a range of *T. azureum* populations in habitat will surely have encountered forms equivalent to the two in question. They unarguably fall within the range of natural variation. Recent images of wild raised seed corresponding to both may be seen in Clifton (2007b). A fine, full-plate botanical painting by Eugenio Rafols Sierra of the ‘var. *grandiflorum*’ form taken from

wild material and corresponding precisely in every detail to Sparre's description above was published in a popular 'coffee table' survey of the Chilean flora (Muñoz, 1966). Somewhat later, another painting of wild material corresponding to the same form appeared in a popular field guide (Hoffmann, 1980). Sparre clearly lacked personal experience of the genus in the wild in Chile, so in that respect his comment is readily explicable. Although Carlos Muñoz was a personal friend (C. Muñoz, pers. comm.), we must presume that Sparre had left Chile by the time the 1966 work was published, and it was perhaps unavailable to him in Europe. The Hoffmann guide almost certainly evaded the monograph authors' researches as well. We would only add that it does seem somewhat imprudent to have pronounced these forms as indubitable garden products!

This species may frequently be seen growing and even intertwining with *T. tricolor* and *T. x tenuirostre* over considerable stretches of countryside (pers. obs.). We have searched extensively for potential hybrids where they mix, but have never encountered any. *T. azureum* is constantly visited by abundant numbers of honeybees and very occasionally by large, black native solitary bees (pers. obs.). We have never seen the same insects on the other two taxa. *T. azureum* is known to have crossed artificially but spontaneously in cultivation with *T. brachyceras* (Dietrich, 1846). ITS DNA analysis places it in close alliance to the other members of the sect. *Gracilia* clade. A deliberate attempt to cross with *T. tricolor* in cultivation is strongly recommended. Apart from the useful systematic information this would provide, the resulting hybrid might be very beautiful indeed. Several of the coarse, annual, tropical vines of sect. *Tropaeolum* such as *Tropaeolum deckerianum* Moritz & H. Karst. possess dark blue petals and a long, red spur (Lemaire & van Houtte, 1849). Any tried out in cultivation have not persisted. A dainty, hardier perennial equivalent would be a very desirable addition to our canon of available garden flowers.

19b. *Tropaeolum lepidum* var *luteum* Reiche, Anales Univ. Chile 93:594. (1896).

Type: Chile, Valparaíso Region, Aconcagua Province, Petorca, Hacienda Mauro, Reiche s.n. (holotype: SGO).

Syns: *Tropaeolum reicheanum* Buchenau ex Reiche, Flora Chile 1:360. (1896).
Tropaeolum luteum (Reiche) Buchenau, Bot. Jahrb. Syst. 26(5):593. (1899).



Fig. 44. *Tropaeolum azureum* (F&W 11957) in habitat. Mid Aconcagua river valley, Valparaíso Region, Chile. September 23, 2010.



Fig. 45. *Tropaeolum azureum* (F&W 11700). Chacabuco Pass, Los Andes, Aconcagua Province, Valparaíso Region. September 25, 2008.



Fig. 46. *Tropaeolum azureum* (F&W 6950). Polpaico, Metropolitan (Santiago) Region. September 18, 1991.



Fig. 47. *Tropaeolum azureum*, pale lilac form (F&W 11699A). Such forms vary rather, and are always notably rarer than albinos (likely part-parents) which they apparently invariably accompany. Cerro La Virgen, Los Andes, Aconcagua Province, Valparaíso Region, Chile. September 24, 2008.



Fig. 48. *Tropaeolum azureum* (at *T. lepidum* type locality) (F&W 8556). Note the consistently darker corolla coloration and linear leaflets compared with most allopatric southern segregates. Cuesta Del Espino, Combarbalá Province, Coquimbo Region, Chile. September 1997.



Fig. 49 *Tropaeolum azureum*, white form (F&W 6550A). Although uncommon, occasional individuals or even groups may be encountered randomly from time to time in various populations. Cerro La Virgen, Los Andes, Aconcagua Province, Valparaíso Region, Chile. September 10, 1997.



Fig. 50. *Tropaeolum azureum* (at *T. lepidum* type locality) (F&W 8556). Cuesta Del Espino, Combarbalá Province, Coquimbo Region, Chile. September 1997.

NOTE: 19b was described as yellow-flowered. No further collections or observations have been made at the type site since. Nor have any other populations of yellow-flowered plants of this species been recorded, or is any such colour dimorphism within a species otherwise known in the genus. This uncertainty is reflected in Buchenau's contemporary nomenclatural judgements via the name changes cited above, as supported by his observation to Reiche (1896b) that the taxon should be allied apart with *T. brachyceras*. We therefore prefer to regard this yellow-flowered plant's status as dubious until or unless further clarification becomes available.

20. *Tropaeolum tricolor* Sw., Brit. Flower Gard. ser. 1, 3: Tab. 270, as 'tricolorum' sphalm. (1828).
 Type: Sweet, R., The British Flower Garden, series 1, 3: Tab. 270 (lectotype).
 Syms: *Tropaeolum coccineum* Miers, Trav. Chile 2:531, nom. nud. (1826).
Tropaeolum elegans G. Don, Gen. Hist. 1:747. (1831).
Tropaeolum tricolor var. *majus* Marmock, Floricult. Mag. 59: Tab. 19. (1837).
Tropaeolum jarrattii Youell ex Paxton, Mag. Bot 5:29, as 'yarrattii', sphalm. (1838).
Chymocarpus tricolor (Sw.) Heynh., Nomencl. Bot. Hort. 1:195. (1840).
Chymocarpus jarrattii (Youell ex Paxton) Heynh., Nomencl. Bot. Hort. 1:195. (1840).
Tropaeolum subincrassatum Steud., Nom. Bot. ed. 2, 2:721, nom. nud. (1841).
Tropaeolum tricolor var. *splendens* A. Reinecke ex Walp. Allgem. Gartenzeit. 12:145. (1844).
Tropaeolum tricolor var. *grandiflorum* A. Reinecke ex Walp. Allgem. Gartenzeit. 12:146. (1844).
Tropaeolum tricolor var. *pallenscens* Barnéoud, Fl. Chile 1:411 (sub *T. pallenscens*). (1845).
Tropaeolum tricolor var. *aurantiacum* C. Morren, Ann. Soc. Roy. Agric. Bot. Gand 4:261, Tab. 207. (1848).
Tropaeolum tricolor var. *grandiflorum* C. Morren, Ann. Soc. Roy. Agric. Bot. Gand 4:261, homonym illeg. (1848).
Tropaeolum tricolor var. *versicolor* C. Morren, Ann. Soc. Roy. Agric.

Bot.Gand 4:261. (1848).

Tropaeolum tricolor var. *venustum* Paxton ex E. Otto, Allgem.

Gartenzeit. 17:306. (1849).

Tropaeolum incrassatum Steud., Flora 39(28):439. (1856).

Tropaeolum violaceum Steud., Flora 39(28):440, nom. nud. (1856).

Tropaeolum tricolor var. *regelianum* Möhring ex Regel, Gartenflora 13:67, Tab. 428. (1864).

Tropaeolum tricolor var. *schultzii* Regel, Gartenflora 13:67, Tab. 428. (1864).

Trophaeum elegans (G. Don) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Trophaeum incrassatum (Steud.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Trophaeum jarrattii (Youell ex Paxton) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Trophaeum tricolor (Sw.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Defining morphology: Slender, delicate, multi-branched, twining vine with tendrilloid petioles, probably always tuberous and perennial, although possibly first-year flowering individuals when under drought stress may be facultatively annual. Throughout its wide geographical range and rather limited variation of colour and form, *T. tricolor* retains certain clearly distinctive characteristics, one of which, unmarked petals, distinguishes it from several closely similar natural hybrids known to ourselves*.

Other characteristic features are the tiny, rounded yellow or green petals, subisomorphic and scarcely if at all exerted from the calyx, and the long, predominant tapering spur of ca 20-25 mm. Flowers are usually bright red to orange with or without blackish purple calyx-lobe tips, but may be paler and even occasionally all-yellow. The spur also at times has a darker apex. Those from the mountains tend to be more slender with longer spurs (see following note).

Distribution: Endemic to a wide area of Chile between Antofagasta and Los Lagos regions, from the coast to lowest Andean alpine sectors. The total range is shortly under 2000 km, but the occurrence frequency becomes more intermittent towards both extremes.

Elevations: From near sea level to 2500 m.

Habitat and ecology: Our recent overview (Watson & Flores, 2010a),

ascribed this ubiquitous species to nineteen of Gajardo's macro-habitats.

*The possible hybrid *T. nuptae-jucundae* x *T. tricolor* mentioned in Sparre & Andersson (1991) would obviously not possess the distinction of veined petals however, given their absence in both putative parents.

In fact, by careful revision we have since increased that to a remarkable twenty-one (G5, G6, G7, G8, G11, G12, G14, G15, G16, G17, G18, G19, G20, G21, G23, G26, G28, G31, G33, G37 & G39)! These are so overwhelming in number that it is difficult to know how to give an idea of their diversity. We personally have come upon *T. tricolor* at the base of Andean screes, either decumbent or lifting itself over scattered low shrubs; climbing up through high montane scrub near the lower Andean zone; decorating a barbed wire fence under a clump of eucalypts by the wayside near our home; twisting skywards through an inhospitable grey tangle of bare, dead lower acacia spines; blanketing coastal shrubs in the mediterranean mist belt; and cascading over tumbled rocks further north in a desert fog oasis. To these Gajardo adds the less humid, more open sectors of Valdivian rain forest, various types of dry deciduous and evergreen littoral woodland, and more variations on these themes. Reducing his overriding categories to their ultimate component plant communities would produce an almost endless list. Hosts used for support and accompanying flora are simply too numerous to consider. We only hope this thumbnail sketch has provided an inkling of the catholic accommodation of this remarkable tribute to adaptive evolution.

Population status: Very widespread and extremely common overall.

Year of introduction: 1828 is stated by Paxton & Hereman (1868) and supported by Sparre & Andersson (1991).

NOTES: Anyone at all familiar with this species in cultivation will immediately be aware that it has been and perhaps still is far more commonly identified as ‘tricolorum’. Indeed, when even known, the correct alternative adjective – *tricolor* – is frequently questioned with suspicion and rejected. Why? If the grammatical error has become predominantly entrenched in the horticultural world, humbler gardeners unquestionably inherited its ‘correctness’ from accredited authorities, including botanists! Fundamentally, from its first introduction the species was inextricably paired with both botany and horticulture. At that early stage its author, Robert Sweet (Brummitt & Powell, 1992), by training and practice essentially a gardener, albeit with a strong botanical bent (Wikipedia, 2009), apparently opted to conjugate it visually and verbally with *Tropaeolum* (Sweet, 1828). His false conjugation stuck and spread from then on, becoming a chronic and continuing universal error even among

the most learned; especially – but by no means solely – in horticulture. There are currently well over 1000 references to ‘*Tropaeolum tricolorum*’ on the Internet! Paxton & Hereman (1868), Darwin (1876), Hay & Beckett (1971), Anderson (1973), Grey-Wilson & Matthews (1983), Brickell (1996), Buchanan-Dunlop (1997), and Cambridge Botanic Gardens (2002) are a random sample of the historic and recent Great and Good following errant Sweet. To those examples might be added the painting of the species by Marianne North (executed in Chile) in her eponymous gallery at Kew Gardens. In pulling some highly respected academic names off our bookshelf for that list (more could be added), including of personal friends, the intention is not to embarrass, but rather to indicate just how ingrained and reflexive the usage became, even at the highest levels. One of the present authors is hardly in a good position to throw stones in greenhouses either after 20-plus early years of ‘tricolorumming’ (Watson, 1976)! Curiously, the misuse appears to be restricted to the Northern Hemisphere. We have only seen *T. tricolor* employed in Chilean sources, even historical. However, the failure of Sparre & Andersson (1991) to cover this major problem at all is a matter of deep regret.

The application of *tricolor* over ‘tricolorum’ can still be strongly disputed. The ultimate absurdity is finding *T. tricolor* cited as a dysfunctional synonym of ‘*T. tricolorum*’ in a major work of reference (Brickell, 1996). To dispel lingering doubts and settle the question beyond all argument, we need look no further than the pages of the ultimate authority in these matters, William Stearn (1966). Compound adjectives containing *-color* such as *tricolor* are not listed alphabetically in the Vocabulary section of his ‘Botanical Latin’. It is necessary to look under ‘Colour’ on page 404, where we find: ‘... **coloured**: in *L. comp.* – color ... *unicolor*, one-coloured; *bicolor*, ... two coloured; *concolor*, of the same colour; *discolor*, ... of different colours; *multicolor*, ... many-coloured ...’. In ‘Botanical Latin’ *bicolor* on page 96 happened to be selected as one fully declined example of: ‘Adjectives and participles with the nominative singular the same in all genders’ (ibid. p. 95). I.e., as already exists for: *Astragalus bicolor*, *Fascicularia bicolor* and *Teucrium bicolor*.

The scholarly Lindley (1837), who corrected the spelling officially, is sometimes cited as the legitimate author of *T. tricolor*. However, Sweet’s original version can clearly be nothing other than an orthographical error, and ICBN Article 60.1. states; ‘The original spelling of a name is to be retained, **except for the correction of typographical or orthographical**

errors ...' (McNeill et al., 2006) (our emphasis). N.B., correction does not invalidate or otherwise affect the original. If the later 1837 version did happen to take precedence, then Don's legitimate name *T. elegans* of 1834 (as in the synonyms above) would in any case have priority unless *T. tricolorum* had been proposed and accepted as a nomen conservandum.

The correct epithet is nevertheless rapidly gaining a firmer foothold of late, at least in authoritative botanical and horticultural circles (e.g., Thomson, 1983, Beckett & Grey-Wilson, 1995, Lord, 2003) and it is to be hoped this influence may spread downwards and outwards.

As noted above, our observations indicate a clear distinction between forms inhabiting areas in the Andes at the altitude limit for the species and those from the lowlands. The former are slender and elongated, the latter have the body of the calyx broader and more boxy, and the spur shorter by comparison. This may indicate the need for formal taxonomic recognition, but not before a thorough investigation to ensure the distinction is constant for upland and lowland forms and above all is discontinuous.

In our recent overview of the section (Watson & Flores, 2010a), we discussed in some detail our hypothesis that *T. tricolor* has evolved rapidly, successfully and relatively recently in biological time in symbiosis with hummingbirds, perhaps exclusively with the ubiquitous lowland green-backed firecrown, *Sephanoides sephaniodes* (Lesson) (Martínez & González, 2004). Although we have never actually witnessed any visits by hummingbirds, there is seemingly overwhelming circumstantial evidence to support our conjecture: the virtually exclusive classical ornithophilous form and colour of the tropaeolum's flowers; the sympatric distribution of bird and plant; the periodic nature of hummingbird feeding, which makes passing, casual observation unlikely. In particular the position of all hybrid crosses observed by ourselves suggests the birds transfer pollen from favoured *T. tricolor* to neighbouring species of *Tropaeolum*, perhaps when *T. tricolor* nectar supply runs out, obliging them to seek alternatives.

It was with considerable surprise therefore that we very recently (during the time of writing) recorded two distinct insect visits to *T. tricolor* flowers. The first (mellitophily) was by the large, fast-flying solitary bee, *Mesonychium gayi* (Spinola), with its unmistakable pale-grey, furry back and black abdomen-tip (Peña, 1996). Although unable to capture it on camera there and then, we do have a portrait from elsewhere. The nectar spur of *T. tricolor* might seem excessively long for the reach of any bee's



Fig. 51 *Tropaeolum tricolor* (F&W 11958). Mid Aconcagua river valley, Valparaíso Region, Chile. September 23, 2010. 7.



Fig. 52. *Tropaeolum tricolor*, a pale form with green petals. Provenance unknown. October 20, 2005. Photograph (anon.) gratefully acknowledged.



Fig. 53. *Tropaeolum x jilesii* (F&V 12222A) and hoverfly (syrrhid) as potential pollinator: Below Casarones, Elqui Province, Coquimbo Region, Chile. November 27, 2010.



Fig. 54. *Tropaeolum azureum* (F&V 11700) seen pollinated by introduced common honey bee, *Apis mellifera* L. We have observed this insect, probably including when naturalised, as an abundant symbiont of *T. azureum* at various localities. September 25, 2008.



Fig. 55. *Tropaeolum tricolor* (F&V 11958) pollinated by a native pierid butterfly, the milk-white, *Lathania leucothea* Molina. September 23, 2010.



Fig. 56. The large, long-tongued, native solitary bee, *Mesonychium gayi* Spinola, an observed pollinator of *Tropaeolum tricolor* (F&V 11958), seen here on *Astragalus amatus* (Fabaceae). Copiapó Province, Atacama Region. October 12, 2010.

tongue. However, they certainly visit long-spurred *T. polyphyllum* in the Andes (Kalin Arroyo et al., 1983). The other (psicophilous) pollinator was the milk-white, *Mathania leucothea* (Molina), a rather uncommon, creamy white, unmarked pierid butterfly (Peña & Ugarte, 1996). This is perhaps less surprising considering the length and articulation of butterfly probosces as well as observation of occasional butterfly visits to hummingbird-oriented tropaeolums in the tropics (Sparre & Andersson, 1991). We did not see either of these insects visiting *T. azureum*, the only other species present, which was attended exclusively by honey bees. As noted elsewhere here, no wild hybrids involving *T. azureum* are known.

21. ***Tropaeolum* x *tenuirostre*** Steud., Flora 39(28):440, (pro sp.). (1856).

Type: Chile, O'Higgins Region, La Leona, Bertero 720 (lectotype: P, isotypes: BM, CONC, FI, GH, LE, MO, P, W).

Syns: *Tropaeolum tenuirostre* Steud., Nom. Bot. ed 2. 2:721, nom. nud. (1841).

**Tropaeolum tricolori-brachyceras* Walp., Allgem. Gartenzeit. 12:145. (1844).

Trophaeum tenuirostre (Steud.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Tropaeolum tenuirostre var. *minus* Buchenau, 33. (1902).

Tropaeolum chilense sensu Sparre, Darwiniana 11:103. (1955), non Bertero ex Colla, Mem. Reale, Accad. Sci Torino: 37:47. (1834).

Defining morphology: This nothospecies (a plant of clearly evident recent natural hybrid origin and not yet stabilised morphologically) is extremely variable in the wild. In our experience one or both parents are almost invariably absent where it occurs. All forms seen by ourselves possess a reddish, brownish or blackish and green bicoloured calyx, upper petals which are veined or similarly marked, and spurs roughly intermediate in length between *T. brachyceras* and *T. tricolor*, though tending to be on the shorter side. Its yellow petals are invariably well-exserted but notably smaller than in *T. brachyceras*. *T. x tenuirostre* can seem close to identical with its parents at the extremes, although even long-spurred forms always have more green in their overall coloration compared with *T. tricolor*, their petals are also

*As may be seen, Walpers's hyphenated binomial antedates legitimate publication of *T. x tenuirostre*. It is accompanied by a type (Sparre & Andersson, 1991) and represents the same parents in an artificially produced cross between *T. brachyceras* and *T. tricolor*. However, it is considered a hybrid formula and so not a proper epithet under ICBN Article H10.3 (McNeill et al., 2006). In addition epithets of both parents are not placed in alphabetical order as required – unless *T. tricolor* was the seed parent, which must then be indicated unambiguously.

somewhat larger and with markings. Those closest to *T. brachyceras* always have longer spurs, but cannot be confused with *T. hookerianum* s.s. as the petals are much too small and peduncles too short.

Distribution: Central Chilean endemic. Although its full extension covers some 230 km between Valparaíso and the north of Maule regions, almost the entire concentration of the nothospecies is centred in the north around and between Valparaíso and Santiago.

Elevations: about 200-1200 m.

Habitat and ecology: Apparently this tropaeolum is always associated with rather vigorous dryland shrubby growth. It is categorised for three such types by Gajardo (G11, G19 & G21), one the coastal formation, another from the interior. The third, also inland is rather less frequent, but the habitat which we have seen: open, very dominant *Acacia caven* Molina (Mimosaceae) high scrub with ephemeral grassy undercarpeting. *T. x tenuirostre* may be seen climbing through discouragingly spiny lower branches of the acacia and other shrubs such as allergenic *Lithrea caustica* (Molina) Hook. & Arn. (Anacardiaceae), often accompanied by *T. azureum*, both tropaeolums to be seen in some quantity. It is very rarely accompanied by one of its parents, *T. tricolor*.

Population status: Widespread, and common to the north of its range.

Year of introduction: No clear early records exist. We (Flores & Watson) successfully introduced this nothotaxon by seed in 1998 and a fine form from that batch is currently in specialist cultivation (R. Rolfe, in litt.). Others have clearly also distributed it since, probably always mistakenly under the name of *T. brachyceras*, as was the case with Chiltern seeds implicit by description and explicit by a photograph of Roger McFarlane in Clifton (2001). Later the same situation is reported with Plant World as the seed suppliers (Clifton, 2008b). In this issue the photograph is by Rosemary Wilson and *T. beuthii* is suggested by Clifton as a possible identification.

NOTE: Distribution of wild populations is fairly extensive. This nothospecies is firmly established, but outstandingly polymorphic. Our conclusion? A vast range of recent hybrid swarms, probably the cross having arisen on many occasions, with a complex introgressive reticulation of continuing back crossing.



Fig. 57. *Tropaeolum x tenuirostre* (F&W 11962) in habitat. Rungue reservoir, Metropolitan (Santiago) Region. September 24, 2010.



Fig. 58. *Tropaeolum x tenuirostre* (F&V 11962). Rungue reservoir, Metropolitan (Santiago) Region. September 24, 2010.

22. *Tropaeolum brachyceras* Hook. & Arn., Bot. Beechey Voy. 14. (1830).
 Type: Chile, Valparaíso Region, Valparaíso, Bridges, **s.n.** (lectotype: K, isotype: LE).
 Syns: *Tropaeolum minimum* Miers, Trav. Chile 2:531, nom. nud. (1826).
Tropaeolum chilense Bertero ex Colla, Mem. Reale, Accad. Sci Torino: 37:47. (1834).
Chymocarpus brachyceras (Hook. & Arn.) Heynh., Nomencl. Bot. Hort. 1:195. (1840).
Tropaeolum brachyceras var. *grandiflorum* A. Reinecke ex Walp. Allgem. Gartenzeit. 12:145. (1844).
Tropaeolum brachyceras var. *sulphureum* Walp. Allgem. Gartenzeit. 12:145. (1844).
Trophaeum brachyceras (Hook. & Arn.) Kuntze, Revis. Gen. Pl. 1:97 (1891).
Trophaeum chilense (Bertero ex Colla) Kuntze, Revis. Gen. Pl. 1:97. (1891).

As also with *T. azureum* (q.v.), Heshkovitz et al. (2006) uncovered polyphyletic differentiation between materials analysed as *T. brachyceras* which had been collected from the Metropolitan (Santiago) Region, and from the coast of southern Coquimbo Region. Again, these respective southern and northern elements may be allopatric. This situation must await further specialised evaluation as there appears to be no obvious visible morphological difference between the two geographical genotypes. All type material cited above originates from the intermediate coastal hill sector near Valparaíso, and therefore cannot be potentially assigned to either clade. Further ribosomal DNA analysis of a wider and comprehensively sampled geographical range would clearly be of systematic value.

Defining morphology: Tuberous, perennial. A slender, delicate vine, multi-branched and twining, with tendrillous petioles. With its short-spurred (4-5 mm), small, yellow flowers, this species is only likely to be confused with its own hybrid *T. x tenuirostre*, *T. nuptae-jucundae*, or *T. hookerianum*. The latter has evidently larger corollas on peduncles double the length (ca 40-50 mm), and a somewhat longer spur. *T. x tenuirostre* always has a longer spur too, and its calyx is more or less bicolored as opposed to all-green in *T. brachyceras*. *T. nuptae-jucundae* has the upper two petals unmarked,

whereas those of *T. brachyceras* are veined dark purplish at the base.

Distribution: Endemic to northern central Chile.

Elevations: Sea level to around 1200 m.

Habitat and ecology: A good range of adaptability is indicated by the half dozen Gajardo categories (G11, G14, G16, G17, G21 & G22). These involve a variety of woody-based, mediterranean-type phyto-communities, from the littoral back to the scub-covered hills within the city bounds of Santiago. We know it mainly from the extreme north of Valparaiso Region to a southern Coquimbo Region stretch of coast within the sound of Pacific breakers, where it creeps over maritime shrubs, or at times up the posts and along the wires of boundary fences. Sometimes it ventures slightly inland and grows more exuberantly in sheltered hollows and valleys.

Population status: Widespread and common. However, the polyphyletically distinct populations from southern Coquimbo are rated as 'Vulnerable' in the Red Data book of the Region (Marticorena et al., 2001).

Year of introduction: Paxton & Hereman (1868) cite 1830, but Sparre & Andersson (1991) note that G. Don (1831) reports it as already in cultivation by 1828.



Fig. 59. Habitat of *Tropaeolum brachyceras* (BC&VV 4132). Typical Pacific coastal heathland with dominant Asteraceae bushes - senecios & *Bahia ambrasioides*, as frequented by the allopatric northern group of the species. Los Vilos Province, Coquimbo Region, Chile. October 21, 1971.



Fig. 60. *Tropaeolum brachyceras* (F&W 6955) availing itself of a convenient rustic wayside fence for support. Los Molles, Valparaiso Region, Chile. September 19, 1991.

23. *Tropaeolum hookerianum* Barnéoud, Fl. Chile 1:415. (1845) subsp. *hookerianum*.

Type: Chile, Coquimbo Region, Talinay, Gay 757 (lectotype: P, isotypes: F, GH, K, LE, P).

Syn.: *Trophaeum hookerianum* (Barnéoud) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Defining morphology: Tuberous perennial. A slender, delicate vine, multi-branched and twining, with tendrillous petioles. This type subspecies falls midway, both geographically and in visible morphology, between *T. brachyceras*, which is clearly smaller in all its floral parts, and *T. beuthii*, which distinctly exceeds it in corolla size and spur length. The two most useful characters are the peduncle, at ca 40-50 mm twice that of *T. brachyceras*; and stout, conical spur of no more than ca 6 mm long, as opposed to the slender equivalent of *T. beuthii*, never less than ca 8 mm. A frequent tendency for flowers to cluster at 'telescoped' internodes is also a helpful characteristic.

Distribution: Endemic to Chile. Restricted to coastal hills and valleys of the northern half of Coquimbo Region between Fray Jorge and El Teniente, a distance of less than 50 km.

Elevations: About 100-400 m.

Habitat and ecology: With so short a distribution, a mere two Gajardo categories (G14 & G16), coastal shrub-dotted steppe and the same type somewhat more inland, come as no surprise. Again, personal knowledge and delving deeper into Gajardo will show this as deceptively simplistic. The type subspecies proliferates grandly over dense, low shrubberies at the entrance to Fray Jorge National Park. To the south, on the plateau heights of Talinay, near the talcum mine, the open, windy exposure has reduced the skyline of foliage to resistant columnar cacti and statuesque *Puya chilensis* Molina (Bromeliaceae) rising above a lower sea of squat Asteraceae shrubs – yellow senecios and white *Bahia ambrosioides* Lag. Here the tropaeolum is dwarfed in foliage but retains full-sized flowers, transmuting to a thing of bonsai exquisiteness as it inches up over puyas and twiggy shrubs whether dead or alive, or creeps decumbent across the ground seeking support. It is accompanied by a diverse and colourful mediterranean-type spring flora, including *Leucocoryne purpurea* Gay (Alliaceae), *Oxalis arenaria* Bertero ex Colla, *O. gigantea* Barnéoud (Oxalidaceae) and loasas. Continue to its southern limit at even more exposed El Teniente, where the ground is open, fairly bare and stony, with little if any supportive vegetation, and it



Fig. 61 Habitat of *Tropaeolum hookerianum* subsp. *hookerianum* (BC&W 4135). One of the taxon's several slight ecological adaptations, here a local community including ephemeral grasses and herbs, *Bahia ambrosioides* (Asteraceae), *Puya chilensis* (Bromeliaceae) and *Leucocoryne purpurea* (Alliaceae). Talinay, Coquimbo Region, Chile. October 22, 1971.



Fig. 62. *Tropaeolum hookerianum* subsp. *hookerianum* (BC&W 4135) in habitat. Talinay, Coquimbo Region, Chile. October 22, 1971.



Fig. 63 *Tropaeolum hookerianum* subsp. *hookerianum* (F&W 7063). Talinay, Coquimbo Region, Chile. September 29, 1991.

will be seen as a quite thriving colony which is almost entirely floored, i.e. decumbent by default.

Population status: Common within its limited range, although already at places falling within the extensive fenced-off terrain of future holiday and retirement home developments: so vulnerable.

Year of introduction: No early records exist. We (Beckett, Cheese & Watson) distributed seed in 1972, which was subsequently raised and flowered (K. Pickard-Smith, pers. comm.).

24. *Tropaeolum hookerianum* subsp. *pilosum* J.M. Watson & A.R. Flores, Gayana Bot. 57(1):63. (2000).

Type: Chile, Coquimbo Region, Elqui Province, Quebrada Maitencillo, 16 km N of Andacollo, 400 m, Flores & Watson **8580** (holotype: SGO, CONC, isotypes: K).

Defining morphology: Identical with the type subspecies except for the pilose peduncles.

Distribution: Endemic to northern central Chile. Only known from the type locality below Andacollo to the north of Coquimbo Region.

Elevation: 400 m.

Habitat and ecology: A spot endemic can only rate one Gajardo category (G15). To put flesh on the bones, we found a modestly thriving colony spread over a fairly sharply sloping hillside dominated by quite closely set shrubs of *Pingraea marginalis* (DC.) F.H. Hellw. (Asteraceae). Between them was a tangle of *Loasa tricolor* Ker-Gawl. (Loasaceae) annual vines looking a slightly darker, duller, less lively yellow than the tropaeolum. The hillside presents a south exposure: that is it faces away from the Southern Hemisphere sun. The tropaeolum tends to occupy the foot of the slope in most strength, doubtless where more moisture accumulates. Any doubt as to its local relative abundance when conditions are favourable may be dispelled by the fact that one of us (Flores), when a young student, spotted it from a fast-moving bus as a conspicuous and considerable patch of colour, and bore it in mind until after we had met and were able to investigate it together a good few years later. Bad years of insufficient rainfall are epitomised by our visit this season (2010), when not a single plant could be found.

Population status: Rare and potentially extremely vulnerable to any threatening human activity, even though locally common in years of good rainfall.

Year of introduction: A deliberately extremely limited collection was made available to one or two specialist growers by ourselves (Flores & Watson) in 1998 at the time of discovery. At least one plant was flowered (R. Wilson, in litt.), but so far as we know, the subspecies has not persisted in cultivation.

NOTE: A population of *T. hookerianum* s.l. observed at Socos, 75 km southwest of the *T. hookerianum* subsp. *pilosum* type site was found to have minutely pubescent peduncles (pers. obs.). This is not of itself considered

Fig. 64. Habitat of *Tropaeolum hookerianum* subsp. *pilosum* (F&V 8580). The type and only known location, a sharply sloping south (i.e. facing away from sun) hillside, largely covered by *Pingraea* (*Baccharis*) *marginalis* (Asteraceae) and *Loasa tricolor* (Loasaceae). Below Andacollo, Coquimbo Region, Chile. September 21, 1997.



Fig. 65. *Tropaeolum hookerianum* subsp. *pilosum* (F&V 8580). Note the clearly evident diagnostic peduncle indumentum. Below Andacollo, Coquimbo Region, Chile. September 21, 1997.

by us to represent a significant break in discontinuity between the two subspecies, notwithstanding Sparre & Andersson (1991) having described the type subspecies as “... sometimes finely puberulous ...”, but further investigation of higher ground between Andacollo and Socos might clarify the situation one way or the other.

25. *Tropaeolum beuthii* Klotzsch, Allg. Gartenzeitung (Otto & Dietrich) 18:161. (1850).

*Type: Chile. Antofagasta or Tarapacá Regions, Cobija, Iquique or Arica, Cuming **914** (neotype: BM, isoneotypes: CGE, E, K).

Syns: *Tropaeolum benthamii* Van Houtte, Fl. Serres 12:44, sphalm. (1857).

Trophaeum beuthii (Klotzsch) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Tropaeolum leptoceras I.M. Johnst., Contr. Gray Herb. 85:150. (1929).

Defining morphology: Tuberous perennial. A slender, delicate vine, multi-branched and twining, with tendrilloid petioles. Even larger bright yellow flowers combined with a prominent, slender spur of 8-10 mm readily distinguish this taxon from the only other species it is likely to be confused with, i.e. *T. hookerianum* s.s.

Distribution: Endemic to Chile's desert north. It is known from two disjunct coastal localities on either side of the Tropic of Capricorn, but both in Antofagasta Region; Tocopilla and Paposo, 300 km to the south.

Elevations: Near sea level to ca 200 m.

Habitat and ecology: This species is confined to two specialised Gajardo categories (G4 & G5), the coastal desert vegetations of Tocopilla and Talal. Both are near the northern limit of Chilean Pacific vegetation, beyond which the coast is mere sterile geology above the waterline. But these coastal desert oases are conjoured up by Pacific fogs and occasional El Niño downpours, which may be separated by a decade or more. The xerophytic plant inhabitants have evolved their different strategies to lie

*Hugh Cuming (1791-1865) was sailing northwards up the South American Pacific coast in his specially constructed sea- and botanical-specimen collecting yacht throughout 1831, making intermittent landfalls to explore for plants (Coats, 1969). At the time the regions he indicated were parts of Bolivia and Peru. They only became official Chilean territory in 1883 after her comprehensive victory in the Pacific (or Nitrate) War (Villalobos, 2007). As for the exact locality of the type collection, *T. beuthii* is not nowadays known outside Antofagasta Region, so Cobija, the southern of the localities mentioned by Cuming, is by far the most likely, as well as the one cited by Klotzsch (Sparre & Andersson, 1991). That also places it in geographical proximity to two later and indisputable collections as cited by the monographers.



Fig. 66. *Tropaeolum beuthii* (F&W 11025A) in Pacific fog oasis habitat. Quebrada El Medano, Paposo, Antofagasta Region, Chile. October 21, 2005. Photograph by A.R. Flores.



Fig. 67. *Tropaeolum beuthii*. (F&W 11025A). Quebrada El Medano, Paposo, Antofagasta Region, Chile. October 21, 2005. Photograph by A.R. Flores.



Fig. 68. *Tropaeolum beuthii*. (F&W 8990). Quebrada Miguel Díaz, Paposo, Antofagasta Region, Chile. October 24, 1999.

patiently dormant for as long as it takes, and then explode into a biodiverse paradise of colour. Their elements are all relict remnants of a former more equable climate, or migrants from Peru, or arrivals from Goodness knows where, but the mixture is a marvel of natural history and contains many endemics, evolved through isolation. This tropaeolum is one such, as well as a survivor of easier days. At all events it looks well adapted to present circumstances. North of Paposo is situated a long, raking, dry, steep-sided east-west valley (*quebrada*) exiting from the coastal mountains, floored with boulders and shrubs, and walled by cliffs, soil banks, outcrops and scree. Here the tropaeolum may be seen equally at home draping over shrubs, adopting the matchless protective support of fiercely spiny large cacti, or as an optional prone scree dweller. It may also be noticed by the roadside on the climbing drive east out of Paposo, zig-zagging between rather bare shrub stems.

Population status: Very restricted overall, but locally fairly common.

Vulnerable to goat grazing and any future human pressures

Year of introduction: We (Flores & Watson) successfully introduced the species by seed in 2003.

26. ***Tropaeolum austropurpureum*** (J.M. Watson & A.R. Flores) J.M.

Watson & A.R. Flores, Curtis's Bot. Mag. 27(3):248, Figs A-H, 243, Tab. 678. (2010).

Basionym: *Tropaeolum hookerianum* subsp. *austropurpureum* J.M. Watson & A.R. Flores, Gayana Bot. 57(1):62. (2000).

Type: Chile, Coquimbo Region, Choapa Province, S of road junction to Combarbalá, 100 m, Flores & Watson **8553** (holotype: SGO, isotypes: CONC, K).

Defining morphology: Tuberous perennial. A slender, delicate vine, multi-branched and twining, with tendrilloid petioles. In overall and detailed form this species matches *T. hookerianum* s.s. very closely. An infallible distinction is to be found in the unique bright pink to strong purple corolla colour of *T. austropurpureum*. There is also extensive veining on its upper petals, and the calyx is heavily lined and patterned compared with the plain green of *T. hookerianum*. We believe the last two discontinuities are noted for the first time here.

Distribution: Endemic of northern central Chile, Coquimbo Region, with a littoral range extending southwards somewhat over 30 km to just north of Huentelauquén.

Elevations: Ca 100-300 m.

Habitat and ecology: We attribute just one Gajardo category (G16) to this newcomer, coastal mattoral (dryland) scrub and high, bushy, mediterranean-type shrubby steppe. But that category is of such floral richness and variability it would take much space to describe thoroughly. Suffice it to add here that this *tropaeolum* is equally at home in dense, tallish, lush shrubberies, or snaking up an exposed cactus column spine by spine, even though its form in such drier, more exposed and arid aspects is considerably more reduced.

Population status: Locally common, but vulnerable throughout its range to potential habitation expansion and other human developments and interventions.

Year of introduction: Our first of several successful and persistent distributions was made in 1998. At about the same time the species (then a subspecies) was offered elsewhere erroneously as *T. lepidum* (pers. obs.). This misidentification persisted for several years, but has now apparently been corrected at source (R. Wilson, in litt.), although it may perhaps still be grown by some as *T. lepidum*.

NOTE: Further detail about this species may be found in Watson & Flores (2000, 2010a, 2010b) and there is an additional photographic image in Watson (2008).



Fig. 69. *Tropaeolum austropurpureum* (F&W 8553) festooning valleyside shrubs at the type locality. North of Huentelauquén, Canela Province, Coquimbo Region, Chile. September 1997.



Fig. 70 *Tropaeolum austropurpureum* (F&W 8553). North of Huentelauquén, Canela Province, Coquimbo Region, Chile. September 1997

27. *Tropaeolum nuptae-jucundae* Sparre, Opera Bot. 108:35. (1991).

Type: Chile, Araucania Region, Malleco Province, Angol, Montero **4696** (holotype: S, isotype: Tem.Gm).

Defining morphology: Tuberous perennial. A slender, delicate vine, multi-branched and twining, with tendrilloid petioles. This species much resembles a smaller version of *T. brachyceras*. However it not only differs by the diminutive corolla and more distinctly inflated (knob-like), darker apex to the spur, but most obviously by the lack of purple guide-veining on the upper petals. (See also *T. tricolor* for discussion on potential hybrid with that species).

Distribution: Endemic to southern central Chile. Occupies a rather broad range of latitude over 230 km between the south of Maule Region and the Angol district. NB. The distribution of this species was taken as belonging to *T. brachyceras* before Sparre recognised the two taxa as distinct (Sparre & Andersson, 1991).

Elevations: About 50-300 m.

Habitat and ecology: Of Gajardo's five categories (G24, G26, G28, G29 & G30), four are deciduous, cooler mediterranean-type woodland, the fifth xerophyllous woodland nearer to the mountains. There is a great diversity

of tree cover in this area centred on the Biobío Region, and the woodland types are based upon local dominance of one species or another, often in strongly mixed communities. *T. nuptae-juncundae* is evidently a slender plant that reaches no more than 3 m in total extent. As with all arboreal species, we imagine it tends to inhabit leafy fringes and hedgerows with sufficient light and support. Unfortunately the native vegetation has been destroyed massively to be replanted by pine plantation monocultures. But recent encounters (e.g., Hernández- Pellicer, 2005) suggest this species is surviving and making out, either by adapting to modified habitats, or finding sufficient remnant native communities, or perhaps both.

Population status: Apparently reasonably common and unthreatened.

NOTE: The monograph suggested likely relationships with *T. brachyceras* and *T. rhomboideum*. DNA analysis has rejected the former but confirmed the latter. *T. kingii* forms a third in their clade-branch, and it is interesting that these three more purely inland species of the mediterranean and Pacific desert alliance form a somewhat distinct group from those inhabiting the littoral zone and its environs.

28. *Tropaeolum rhomboideum* Lem., Fl. Serres Jard. Eur. 3:236. (1847).

Type: Chile, Metropolitan (Santiago) Region, near San José de Maipo,

Looser **s.n.** (neotype: G, isoneotypes: CONC, SGO).

Syns: *Trophaeum rhomboideum* (Lem.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Tropaeolum tenuirostre Steud var. *majus* Buchenau, Pflanzenr. 4, Fam. 131:33 (1902).

Defining morphology: Tuberous perennial. Although basically also a slender, twining climber with sensitive, cirrrose petioles, this species, which ranges from foothills to lowish Andean alpine elevations, differs somewhat in form and habit from others in subsect. *Gracilia*. It may be seen growing prostrate on flat, bare ground or trailing down steep banks. Sparre & Andersson (1991) state its height as 2-3 m, whereas Navas (1976) indicates the maximum at 2 m. Both those measurements must be derived from specimens at the species's lowermost occurrence. The lanceolate to elliptic leaflets also differ from the norm in being somewhat thicker and firmer and also rather glaucous at times. The diagnostic flower shape in life is discussed in the following notes. A further strongly characteristic and unique feature of the living flower is distinctive light sepia-brown tinting

of the calyx and slender spur of at least 10 mm. This contrasts strongly with the rich, rather old-golden yellow of the petals.

Distribution: Endemic of Chile. Restricted to the Maipo and Colorado river valleys just southeast of Santiago, and reaching up into the adjacent cordillera, with a range covering a maximum of a little more than 30 km, if that.

Elevations: 900–2250 m. The upper altitudinal limit given in Sparre & Andersson is 2000 m. In the course of our first exploration of the Chilean flora during 1971 and 1972 (Beckett, Cheese & Watson), we encountered, collected and photographed a small colony growing somewhat above the ski centre at Lagunillas, which is situated at 2200 m (Watson, 1976). This sector has been heavily grazed and trampled by horses since, resulting in ecological degradation. In addition, a vast, foaming cream sea of flowers of the introduced weed pest *Cardaria draba* (L.) Desv. (Brassicaceae) has also invaded the entire lower portion of the basin meanwhile, and we have been unable to rediscover *T. rhomboideum* above the ski centre. Higher, the fairly shallow upper ski slope of the bowl still remains heavily populated by *T. sessilifolium*. Apropos: the undiluted mountain sunlight had so bleached the *T. rhomboideum* flowers that its ground colour was embarrassingly described as white in the cited 1976 account!

Habitat and ecology: From the literature and our own observations at Lagunillas, this species categorises in Gajardo as from low Andean xerophyllous shrubberies and upper mountain steppe (G11 & G12). It is often a quite short-stemmed climber at the latter, well under a metre in extent. The dwarf to relatively compact, twiggy shrublets and shrubs *Trevoa trinervis* Miers (Rhamnaceae), *Tetraglochin alatum* (Gillies ex Hook. & Arn.) Kuntze (Rosaceae), and *Guindilia trinervis* Gillies ex Hook. & Arn. (Sapinaceae), all commonplace at upper montane elevations of Lagunillas, make ideal supports. Higher still it used to accompany *T. sessilifolium* at the base of the slopes used for skiing in winter, climbing over *Anarthrophyllum andicola* for support. As already noted, we have not seen it at that upper station for decades and fear it may have been eliminated there.

Population status: Although local populations are recorded as quite dense and flourishing, every one of its limited number of sites is close to Santiago city. All must be considered highly vulnerable to any future human activities, including development.

Year of introduction: An inadequate collection made by ourselves (Beckett, Cheese & Watson) in 1972 failed to produce results. However a later

repeat by us (Flores & Watson) has resulted in its flowering and possible establishment in specialised horticulture.

NOTE: One strong characteristic of *T. rhomboideum* in life, which does not show up in Sparre's inaccurate monograph drawing (Sparre & Andersson, 1991), is the distinctly vertically oblong face-on shape of the corolla. One is almost tempted to call it 'hang-dog'! This is due in no small measure to the long, narrow lower petal claws, which project the rounded, emarginate blades well clear of the calyx, and the forwards-inclined and clearly larger upper petals. The effect is enhanced by a distinctly 'toed-in' or subinclined posture of the two outer lower petal blades. None of this is portrayed in the drawing, where stamens and style are also wrongly shown as exceeding the petals. Furthermore no mention is made of those distinctive petal claws in the text description.



Fig. 71 *Tropaeolum rhomboideum* (F&V 8609) in habitat (bottom right hand corner). Lagunillas, Cordillera de Santiago, Maipo, Metropolitan Region, Chile. October 1997.



Fig. 72. *Tropaeolum rhomboideum* (F&V 8609). Lagunillas, Cordillera de Santiago, Maipo, Metropolitan Region, Chile. October 1997.

29. *Tropaeolum kingii* Phil. Anales Univ. Chile 41:684. (1872).

Type: Chile, Atacama Region, Yervas Buenas, King 7 (holotype: SGO).

Syns: *Trophaeum kingii* (Phil.) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Tropaeolum buchenau Phil., Anales Univ. Chile 83:895. (1893).

Defining morphology: Tuberous, perennial. A slender, delicate, but quite vigorous and sometimes high-climbing vine, multi-branched and twining, with tendrilloid petioles. The variable but always distinctly pale corolla colour of cream, parchment, greenish to brownish yellow or pale lemon is diagnostic. So too is the prominent, usually – perhaps always – striped, upcurved spur at least 10 mm long terminating the green- or brown-patterned calyx which can also be quite dark chocolate brown overall. Foliage is characterised by its narrow linear to sublinear divisions exceeding 1 mm in width.

Distribution: Endemic to Chile. The total extension covers roughly 350 km between Copiapó and Monte Patria, but records appear to be very sporadic and the main concentration is found in Coquimbo Region, about 80 km to the south of the Elqui valley.

Elevations: 900-1500 m.

Habitat and ecology: Three Gajardo categories (G7, G8 & G15) delimit the species, two of them specifically referring to the intermittent flowering desert to the north of its range, and one to the xerophyllous, small-leaved, evergreen shrub and woodland relief of the higher interior, including Andean foothills, which is its major stronghold. The only encounter we have registered in the desert was at the base of a scorchingly hot, low run-off gully, where the tropaeolum grew out of the fractured, stony floor and clung horizontally to the leafless twigs of a long-dead, fallen baccharis. Without any cover or protection in that parched and generally desiccated habitat, it looked astonishingly fresh for such a delicate expression of life. Our other sightings have been in the more usual dryland shrubberies and light woodland of Coquimbo Region. At one of these sites it thrives in considerable quantities, stitching up through the shiny leaves of dominant, densely shrubby, head-high *Larrea nítida* Cav. (Zygophylliaceae). Years before we found just one high-reaching specimen in rather taller light woodland, where its joint supporting hosts were *Porlieria chilensis* I.M. Johnst. (Zygophyllaceae) & *Colliguaja odorífera* Molina (Euphorbiaceae)

Population status: Locally common as seen. Probably even more common than appreciated due to inaccessibility of typical habitats. Marticorena et

al. (2001) record it as unthreatened in Coquimbo Region.

Year of introduction: Sparre and Andersson (1991) reported that our Beckett, Cheese & Watson 1972 introduction was cultivated at Kew in 1973-74. That very limited distribution evidently failed to establish and it has so far not proved possible to make a further viable collection.

NOTES: An interesting morphological feature found in some forms is exceptional elongation of the linear leaflets. These droop gracefully when mature like leaves of a weeping willow. This is a natural growth phenomenon, not the result of die-back damage or drought, and was observed in several individuals of a population. Whether it is a periodical phenomenon rather than constant throughout day and night, or brings any advantage to the plant, we are unable to say. NB. The leaflet measurements given in Sparre & Andersson (1991), 5-6 x 0.5-1 mm are a gross and inexplicable error. Although always more or less linear, the divisions are usually longer and always notably broader in all populations known to us, or as seen depicted in photographs (pers. obs.).

As indicated above, flower colour is fairly variable. The colours are most subtle and very difficult to convey simply and clearly by written description! Although Sparre and Andersson record the species as yellow, we ourselves have never seen a 'pure' bright yellow population comparable in colour to, say, *T. beuthii* or *T. hookerianum*, and until recently doubted whether any true unadulterated yellow-petalled form existed in the species at all. Our minds have recently been changed and educated by photographic images of a pale, pure light yellow form (Hernández-Pellicer, 2005, Descat & Clifton, 2007).



Fig. 73. *Tropaeolum kingii* (F&V 8557). Cuesta Del Espino, Combarbalá Province, Coquimbo Region, September 18, 1997.



Fig. 74. *Tropaeolum kingii* (F&W 11982). A form with notably dark calyx and spur. Vicuña to Hurtado, south of the Elqui valley, Coquimbo province, Chile. October 6, 2010.



Fig. 75. *Tropaeolum kingii* (F&W 11982) in habitat on *Larraea nitida* (Zygophyllaceae) shrubs. Vicuña to Hurtado, south of the Elqui valley, Coquimbo province, Chile. October 6, 2010.



Fig. 76. *Tropaeolum kingii* (F&W 11290). An unusual form with strongly pendent long leaflets. Vicuña to Hurtado, south of the Elqui valley, Coquimbo province, Chile. 30 September, 2006. Photograph by A.R. Flores.



Fig. 77. *Tropaeolum kingii* (F&W 11289). Vicuña to Hurtado, south of the Elqui valley, Coquimbo province, Chile. 30 September, 2006.

DOUBTFUL TAXA

Tropaeolum oxalanthum C. Morren, Ann. Soc. Roy. Agric. Bot. Gand 4:257, Tab. 207, Fig. 5. (1848).

Type: Morren, C.F.A., Ann. Soc. Roy. Agricult. Bot. Gand 4:257, Tab. 207, Fig. 5. (1848).

Syns: *Trophaeum oxalanthum* (C. Morren) Kuntze, Revis. Gen. Pl. 1:97. (1891).

Tropaeolum oxalidanthum Buchenau, Bot. Jahrb. Syst. 22(1):167. (1895).

The original specific epithet is noted as a correctable error by Sparre & Andersson (1991), as subsequently effected by Buchenau. It is not possible, however, to know the intentions of an author, and such names cannot be presumed as typographical errors, so must be allowed to stand according to ICBN Article 60.1 (McNeill et al., 2006), as do other similar apparently inexplicable anomalies: e.g. *Viola portulacea* (Leybold, 1865).

The possible status of this element is discussed in detail in Sparre and Andersson, including the surely implausible alternative of a cross-subsectional hybrid. The subject is so speculative that little worthwhile can be added. For what it is worth we can add that another remote possibility is that this might be an early cultivated introduction of *T. nuptae-jucundae*. There seems no good reason why that species should not have been collected historically. If a hybrid, then surely *T. tricolor* would be a glaringly obvious choice of parent?

Tropaeolum tenellum G. Don, Gen Hist 1:747. (1831).

Type: No extant material known, original as 'v. s. herb. Lamb'.

Syn.: *Trophaeum tenellum* (G. Don) Kuntze, Revis. Gen. Pl. 1:97. (1891).

According to Sparre & Andersson (1991), the short and inadequate description, as well as the usual sources of Don's specimens, strongly support the probability that this originates from between Coquimbo and Santiago and either corresponds with *T. brachyceras* or is a short-spurred variant of *T. x tenuirostre*. Its status is probably therefore either a synonym of the former or an inadequately supported prior name for the latter.

All photographs by J.M. Watson unless otherwise indicated.

NOTE REGARDING FIGURES:

Many photographic captions contain details regarding collectors and specimen collection numbers; the latter have been abbreviated, using the following key:

BC&W = Beckett, Cheese & Watson, 1971-72.

C&W = Cheese & Watson, 1972.

P&W = Pern & Watson, 1987-88.

JW = John Watson, 1991.

F&W = Flores & Watson, 1991-present.

APPENDIX A**HABITAT AND ECOLOGY**

On translating the classification system for the eight natural vegetation categories of Chile based on Gajardo (1994) in the text above, a compromise was aimed at between his original Spanish headings and what will convey their meaning best to non-Chileans. A somewhat different approach was devised for the equivalent corresponding codes 1-8 in the accompanying map caption (Fig. 6). They represent our own alternative interpretation, which is perhaps closer to a more universally understood set of definitions. We might have opted for one or the other throughout, but in our judgement both sets of terms in conjunction actually add to fuller understanding.

Accordingly the eight major phytogeographical regions arranged approximately north to south are listed as both versions coupled below, with the parenthesised lower term, as given in the accompanying map, Fig. 6:

1. Northern Desert (Atacama desert)
2. High Andean Steppe (Altiplano & central temperate Andes)
3. Maquis and Xerophyll Scrub & Woods (Mediterranean zone)
4. Deciduous Woodland (Cleared agricultural land & central to southern woodland.)
5. Broad-leaf evergreen Woodland (Temperate rain forest)
6. Andino-Patagonian Woodland (Southern & subantarctic Andes)
7. Evergreen Woodland & Wetlands (Magellanic wetlands)
8. Patagonian Steppe (Patagonian steppe & tundra)

APPENDIX B

VEGETATIONAL SUBREGIONS INHABITED BY INDIVIDUAL SUBSECTIONS AND THEIR TAXA (mainly after Gajardo, 1994)

Subsect. ***Chymocarpus***: T1, E2, E3, G21, G22, G23, G24, G28, G29, G30, G31, G32, G33, G34, G35, G38, G39.

01) *T. pentaphyllum* subsp. *pentaphyllum*: E2, E3.

02) *T. pentaphyllum* subsp. *megapetaloides*: E2.

03) *T. pentaphyllum* subsp. *megapetalum*: T1.

*04) *T. ciliatum* subsp. *ciliatum*: G23, G24, G28, G30.

*05) *T. ciliatum* subsp. *septentrionale*: G21, G22, G23.

*06) *T. speciosum*: G28, G29, G30, G31, G32, G33, G34, G35, G38, G39.

Subsect. ***Magallana***: G40, P41, P42, P43.

07) *T. porifolium*: G40, P41, P42, P43.

08) *T. trialatum*: P41.

Subsect. ***Trophaeastrum***: P44.

*09) *T. patagonicum*: P44.

Subsect. ***Chilensia***: G9, G10, G11, G12, G13, G15, G21, G25, G26, G27, G28, G32, G36, G37, P41.

*10) *T. sessilifolium*: G9, G11, G12.

*11) *T. x jilesii*: G10.

*12) *T. looseri*: G10, G11, G15.

*13) *T. leptophyllum* subsp. *gracile*: G21, G25, G26, G27, G28, G37.

14) *T. myriophyllum*: G13, G36.

*15) *T. incisum*: G12, G13, G32, G35, P41.

*16) *T. leptophyllum* subsp. *leptophyllum*: G11, G13, P41.

*17) *T. polyphyllum*: G12.

*18) *T. nubigenum*: G12.

Subsect. ***Gracilia***: G4, G5, G6, G7, G8, G10, G11, G12, G14, G15, G16, G17, G18, G19, G20, G21, G22, G24, G26, G28, G29, G30, G31, G33, G37, G39.

*19) *T. azureum*: G5, G6, G8, G10, G11, G14, G15, G16, G17, G18, G19, G21.

*20) *T. tricolor*: G5, G6, G7, G8, G11, G12, G14, G15, G16, G17, G18, G19, G20, G21, G23, G26, G28, G31, G33, G37, G39.

*21) *T. x tenurostre*: G11, G19, G21.

*22) *T. brachyceras*: G11, G14, G16, G17, G21, G22.

*23) *T. hookeriana* subsp. *hookeriana*: G14, G16.

*24) *T. hookeriana* subsp. *pilosum*: G15.

*25) *T. beuthii*: G4, G5.

*26) *T. austropurpureum*: G16.

27) *T. nuptae-jucundae*: G24, G26, G28, G29, G30.

*28) *T. rhomboideum*: G11, G12.

*29) *T. kingii*: G7, G8, G15.

* = known in habitat by the authors.

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SOUTH AUSTRALIAN OUTBACK REVISITED

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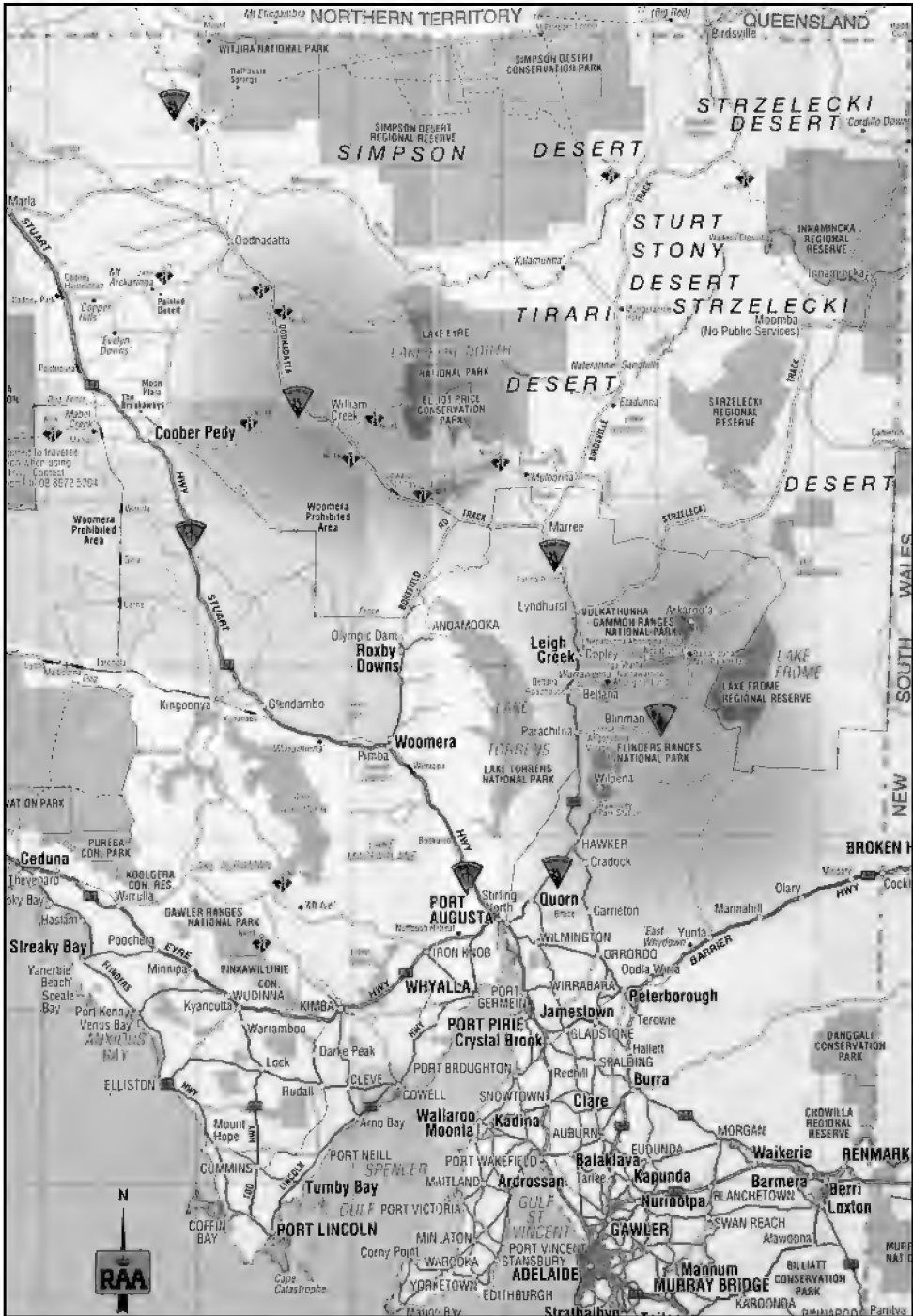
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In early February 2010 the desert areas in the far north of South Australia received rainfall in the 25 to 50 mm range, enough to stimulate the *Crinum* species of this harsh environment into growth and possibly to flower. It took just one phone call to Jim Lycos in Sydney to convince him to join me again for a return trip to the area, following our highly enjoyable visit in February 2007 (Hamilton, 2007). This year the rainfall was further north than that of our previous visit, opening the possibility of finding further populations, including some of those listed on publicly available herbarium records. The *Crinum luteolum* regions just north of Port Augusta and near Quorn had not received much rain, and neither had the desert *Crinum* sites at Andamooka and south of Woomera which we found in 2007.

Friday February 19th started at 3.30am, to enable me to catch a 6am flight to Melbourne and a subsequent connection to Adelaide. I arrived in Adelaide at 9am, and after turning on my mobile phone, I received a disappointing message from Jim. He had been held up by traffic on the way to Sydney airport and missed his flight by an agonising two minutes. He had great difficulty arranging a replacement flight so instead of arriving in Adelaide at 10am, he arrived at 5pm. I filled in my day by visiting the Adelaide Hills including the Mt Lofty Botanical Garden. I had hoped I might find some *Calostemma* in flower in this area, but Mt Lofty appeared to have had very little rain. After meeting Jim at 5pm at the Adelaide airport, we headed straight off on the 320 km trip to Port Augusta. We arrived at 9pm and happily settled in to a roadside motel for the night.

We were on the road at 7am next morning and on our way to the far north. We first travelled through Pichi Richi Pass, the home of *Crinum luteolum*. We knew there had been little rain in this area, and as expected, 99% of the bulbs were dormant. At the Saltia site, half a dozen plants had flowered on the Eastern site of the road. We thought this had occurred because of run off from the road, of the small amount of rain which had



Map 1. Royal Automobile Association of South Australia Map of the Finders Ranges and Outback South Australia (reprinted with permission). Approximate straight line distance between Adelaide and Port Augusta = 300 km.

occurred. It was the same story for Arden Vale Road and Buckaringa Road, know *Crinum luteolum* sites north of Quorn. We continued in a northerly direction on unsealed “back roads” until we met the main north road through the Flinders Ranges. After lunch at Leigh Creek we headed further north and then travelled a 30 km diversion to the east on the Strezlecki Track, where there had been good rainfall. We crossed quite a few dry creek beds over this distance, but soon decided to turn back as it didn’t look to be likely *Crinum* habitat. Twice while travelling this section of unsealed road we saw huge clouds of dust approaching and soon realised they were from large trucks. On both occasions it was two double-road trains travelling in convoy, so we took shelter off the road at sites which were clearly made by other vehicles avoiding the dust and gravel missiles from these large trucks.

We returned to the main north road and after about another 30 km we arrived at Farina Creek, a site we had visited and found desert *Crinum* in fruit in 2007. Here there was excellent flowering of *Crinum* over quite a large area. They were scattered among quite a thicket of grasses and other small shrubs which had also leapt into growth in response to the rain. The best specimen we found had 9 fully open flowers and 5 unopened buds



Fig. 1. Desert *Crinum* at Farina Creek with 9 open flowers.

(Fig. 1). North of Farina Creek we met unsealed road and soon started to find the surface quite churned up. Several times we had to cross water before we reached Marree. This small town with a population of about 170 people was once a thriving connection point for the now defunct Ghan Railway, which connected Adelaide to the Northern Territory. It was also the origin of camel trains which used to service outlying communities in the past. Each year it is the site of an annual camel race, and descendants of the Afghan population who used to run the camel trains still live in the town.

After checking in to the Marree Hotel for the night, we decided to take a 50 km trip north on the Birdsville Track to look at the Clayton River site which was dry and unproductive on our last visit. The road was open to “large 4WD vehicles” which didn’t really apply to our SUV, but we decided to go anyway. Approximately 9 km into our journey, we came across a 40-50 metre wide expanse of water covering the road. Without too much hesitation we decided it wasn’t very deep, so drove into the water. We soon realised our mistake, but it was too late to stop. Our little SUV struggled and occasionally felt as if it had no traction at all, but we made it across. As we travelled on, I had ongoing concern that we had to cross it again on our way back to Marree. A few kilometres further on we came across a herd of 15 to 20 station horses in the middle of the road, with 2 camels that appeared to be an accepted part of the herd. Introduced into Australia many years ago, camels now number 1.6 million in the desert areas and are considered a pest. We found the desert *Crinum* about 150 metres before the Clayton River in its flood margins, with large numbers of plants but only a few producing a weak second bloom, this indicated by mature seed around a lot of plants. The Clayton River region was a vast contrast to our last visit, still with a small flow across the road and a sea of green around a large lagoon on the eastern side of the road. On our return to Marree, we were relieved to see a vehicle on the other side of the expanse of water we had to cross, with several residents from the town having come to view the unusual scene. Knowing help was at hand if we needed was a great relief, and happily, we easily crossed the water. On return to our cabin at the hotel, we quickly turned on the air conditioning as it had reached 38C in the late afternoon. We had an enjoyable evening meal at the hotel chatting to the barman and a couple of “locals”, where we learned a lot of interesting information about the town.



Fig. 2. White desert *Crinum* at William Creek.



Fig. 3. Dry creek bed at William Creek.



Fig. 4 Nice desert *Crinum* at Nilpinna Station at edge of road.



Fig. 5. Oodnadatta Track with typical sandy wash left after rain.

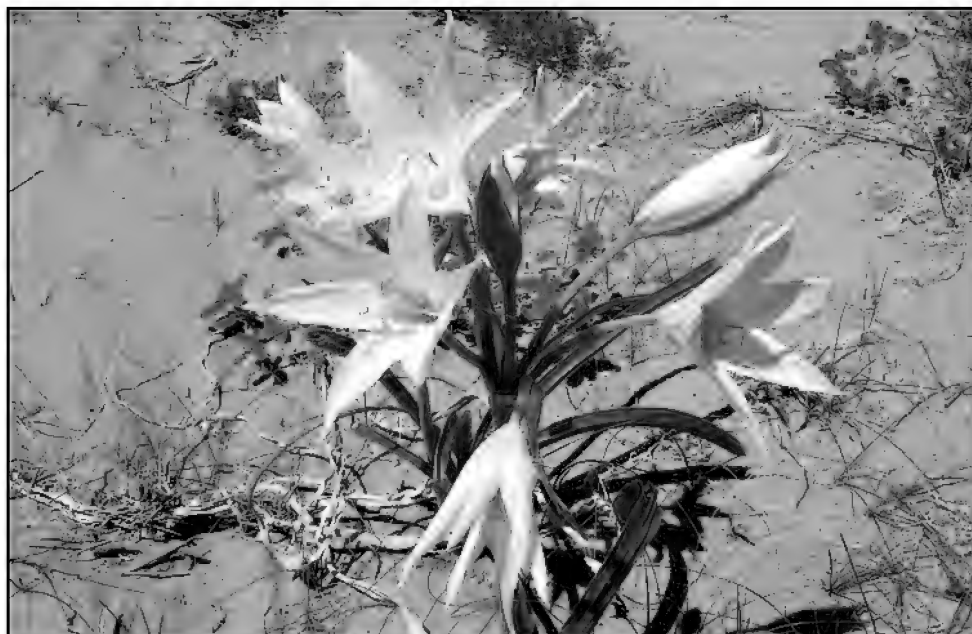


Fig. 6. White desert *Crinum* at Nilpinna Station.



Fig. 7. Washed out edge of dry creek bed at Nilpinna stockyards with exposed bulbs.

I had a sleepless night worrying about potential road conditions and the sheer isolation for the 400 km trip to Oodnadatta the next day. I was very pleased to have hired a satellite phone before leaving home, and I tested it was working before leaving Marree, as well as checking the spare tyre on our SUV. It was 28C at 7am when I emerged from our cabin for the first time in the morning. The first 200 km was uneventful except we did take a short detour, south from the Oodnadatta Track, to Gregory Creek where there were a few flowers on the desert *Crinum* from a second wave of blooming and plenty of mature seed from an earlier flowering. Sites from herbarium records near the old Curdimurka railway station and Coward Springs were not located. We did see a dingo, the Australian native dog, and 3 wedge-tailed eagles during our morning travelling. There is a dingo fence which crosses the Australian continent from west to east, though the interior, to protect sheep from dingo predation. This dog was on the southerly side of the fence, the supposed protected area! The road mostly wasn't in very bad condition until the last 50-60 km from William Creek where it started to become heavily rutted on one side. We decided this was from a vehicle haven driven on the softened road, soon after rainfall. We lunched at the hotel in William Creek. It is the smallest town in Australia with 4 permanent residents. There were two light aircraft at a small airfield which are used to take travellers on joy flights over Lake Eyre. The pilots were currently away on leave, but had apparently been having a busy time since the lake filled again after heavy rain in its Queensland catchments 12 months or so earlier. The tiny town is situated within Anna Creek station which at 34,000 square kilometres (6,000,000 acres) claims to be the largest cattle station in the world. With drought throughout this area from early in the new millennium, there was very little stock to be seen.

Following lunch we travelled in a mainly northerly direction from William Creek, and after about 20 km we came upon a population of the desert *Crinum* in full bloom. It was in a small dry sandy creek bed, no more than 3-4 metres wide, and we could see scattered flowers in the distance on both sides of the road as the dry creek snaked off into the distance. There seemed to be a higher percentage of white flowers in this population, as well as white flowers with cream throats and fully cream flowers (Fig. 2, 3). Mature seed was present around many of the flowering plants, evidence of an earlier bloom. It was common to see the same bulb flowering for a second time.

About 35 km further north, we came across 3 distinct populations over about 2-3 km within the boundaries of Nilpinna Station (Fig. 4, 5, 6, 7). The last of these was adjacent to the station stockyards, and I immediately realised this was a site I had seen on herbarium records. The first of these populations was fairly similar to that at William Creek although a slightly larger dry creek bed, which once again snaked off into the distance with flowers dotted here and there as far as we could see. The sandy dry creek was full of seedlings which were several years old, and there were plenty of mature bulbs in bloom, as well as mature seeds from an earlier bloom. The second site was a small dry creek with plants in leaf but none flowering. There were hundreds of *Crinum* in bloom at the stockyard site, with four or five dry sandy creek beds, wider than the previous sites with the mass blooming over several acres in the flood margins of the creeks. There appeared to be a higher number of creamy yellow flowers here than at the previous sites. As at other sites there was mature seed from an earlier flowering. The sides of the largest creek bed had been eroded by the recent, obviously very heavy flow and had exposed a number of *Crinum* bulbs which were still in leaf and hanging on to life by the last few centimetres of their roots. It seemed reasonable to rescue these bulbs and so avoiding any digging. This was a relief, with the temperature now in the low 40C's and probable 50C in the sun.

As we continued on, the road was badly rutted by wheel tracks from other vehicles, and on many occasions sand had washed into the dry creek beds making their crossing slightly hazardous. We also crossed muddy creek beds and water a number of times. At one such crossing there were a number of black falcons flying overhead, and we realised after watching for a while, they were attempting to catch small fish or other aquatic creatures in the shallows as the water crossed the road. Just 6 km before the town of Oodnadatta, we came across more *Crinum*, once again beside a dry creek bed, but this time they appeared to be growing in quite a heavy, gravelly soil, much different from the sandy situations of all the previous populations. We were too late for flowering, but there was mature seed and fresh pods on the *Crinum*. This was because of slightly different rainfall times here, where rain occurred in late December and late January, a few weeks earlier than the other sites. Much of the mature seed was germinating or had gone soft after being cooked for several weeks in the harsh sunshine. Some of the *Crinum* in leaf were much more robust than

others we had seen that day, and this fact, combined with the different soil type made us wonder whether there had been a change of species. Time will tell.

We were glad to arrive at Oodnadatta which boasts being the hottest and driest town in Australia, and the 43C temperature peak for the day, as we arrived, made that hard to argue against. Rainfall records showed that its average annual rainfall over the period 1940 to 2009 was 175 mm (7 inches) with 43.2 mm the lowest recorded in 2006. It was a shock to find our budget accommodation was little more than a room hardly large enough for 2 single beds, and it had shared toilet and bathroom facilities. Inside it must have been close to 60C having been baked in the sun all day. Jim decided to freshen up with a shower, but unfortunately this facility was at the western end of the accommodation “block” and so was hotter than our room, and he came out more hot and bothered than before he showered. After dinner in fairly oppressive conditions, we left for a drive west of the town for an hour or so while the air conditioner cooled our room.

We decided to leave Oodnadatta at dawn and did so at 6.40am as soon as it was light enough to see the road. Once again the overnight temperature low was 28C. As we left Oodnadatta heading south on the 200 km journey to Coober Pedy, we travelled towards lightning in two separate storm fronts. This was our last journey on unsealed road, but anxiety was high, knowing that if a storm producing significant rain, it could make creeks uncrossable and roads too soft to negotiate. We soon started crossing water lying on the road from rainfall in previous days. After travelling about 50 km the road became wet and the SUV became a little hard to keep on a straight course. I could see we were leaving tyre ruts behind us similar to those we had encountered previously on the Oodnadatta Track, confirming those we had previously negotiated were from other vehicles caught on the road after fresh rainfall. We soon came to a freshly flooded creek with rapid flowing, rising water, and we thankfully crossed it without incident. Fortunately after a few more kilometres the road became dry again, but we remained concerned as dark storm clouds were still ahead. We drove into a light shower of rain a little further on, but it didn't last and the road was soon dry again. At about the halfway mark of our journey we met a vehicle and found from the driver that the road was in easily passable condition for the rest of the journey, so we were able to

relax a little and enjoy the rest of the morning. Because of the state of the road we had decided not to explore a possible *Crinum* site 20-30 km west the Coober Pedy road. In retrospect it could have been easily done, so this decision remains a disappointment. We only met 2 vehicles on this 200 km leg, and it was great to find we had mobile phone reception again when we stopped for a snack 20 kilometres before reaching Coober Pedy. This is another town developed around opal mining, and it was interesting to see underground motels built in old mines, as well as homes built on the top of the mounds of sand left by the mining process.

From there it was great to be back onto sealed roads after about 700 km of soft surfaces. The first leg of the trip, 360 km to Woomera, was uneventful. During a roadside rest we scraped much of the mud and clay from around the wheel cavities of the SUV using a small garden trowel. We had a short break at Woomera and looked around the Space Park which had rockets on display from the time Woomera was involved in space research. The Woomera Rocket Range was a joint British / Australian venture which started in 1947. From 1964 to 1970 the range was an experimental centre for the European Launcher Development Organisation which included 5 other European countries as well as UK and Australia. Its acronym lives on as the ELDO Hotel in Woomera.

The final travel leg for the day was 200 km back to Port Augusta. About 30 km south of Woomera we stopped at a *Crinum* site we knew near the old Wirrappa railway siding. There was no sign of *Crinum* here except for a few dry leaves. After a further 20 km we stopped again at the Oakden Hills site and were delighted to find a few scattered plants in growth. The shallow drainage line through the population was still damp indicating quite recent rain, and it was full of emerging *Crinum* plants, many of which were small seedlings. The few flowers we saw here were smaller than those we had seen over the previous 2 days but were a more intense yellow colour. We found a second population with a few plants in bloom 3 km further south, a site which we had not previously known. The rest of the trip to Port Augusta was uneventful and it was a relief to arrive after 750 km of travel for the day.

On the final night of our trip we relaxed and packed, at the same motel we had stayed at 3 nights before. The next morning we spent quite some time cleaning up the SUV in a local car wash before heading off on the 300 km journey back to Adelaide. This was a relaxed drive and after arriving



Fig. 8 Mass display of *Calostemma purpureum* at Mambray Creek.



Fig. 9. Deep pink flowers of typical *Calostemma purpureum*, Mambray Creek.



Fig. 10. Pale pink flowers of typical *Calostemma purpureum*, Mambray Creek.



Fig. 11. Purple *Calostemma purpureum* flowers, Mambray Creek.



Fig. 12 White *Calostemma purpureum* flowers, Mambray Creek.

in Adelaide, I dropped Jim off to spend a few days with his family, before returning to the airport. I finally arrived home at 11pm that night after a short transit stop in Melbourne.

The excitement of the adventure continued after my return home, and I continued to watch rainfall patterns in South Australia. Five days after arriving home I noticed Andamooka recorded 45 mm of rain. This opal mining town was the site we first saw the desert *Crinum* in bloom, during our 2007 visit, but we had not visited there this year because it had not had significant rainfall. I continued to watch rainfall prediction charts with increasing interest as it appeared the more southerly sites, including the habitat of *Crinum luteolum* were certain to get rain.

Over the weekend of 6th and 7th March, 2010, Port Augusta and Quorn received a total of 17 mm and 22 mm respectively. A little further south 40 mm fell at Mambray Creek which runs through the Mt Remarkable National Park. This latter site was of interest as it is listed on herbarium records as a *Crinum luteolum* site as well as being a known habitat of *Calostemma*, another Australian genus which has true bulbs. It was enough rain for me to make the decision to visit South Australia again, so

I immediately planned to do this on 19th to 22nd of March, 2010. I was sorry to find that Jim was unable to join me on this occasion.

Once again I had a 3.30am start to catch a 6am flight departing from Hobart. I arrived in Adelaide at 9am, and after picking up my rental vehicle, I was pleased to be heading out of the city by 9.30am. I rapidly became frustrated as I ran into heavy traffic which eventually almost came to a standstill. I later found the traffic jam was due to roadwork. My progress was limited to 30 km in the first hour, but thereafter I maintained good progress, arriving at the Mambray Creek turnoff, 40 km south of Port Augusta, at about 1.30pm.

The Mt Remarkable National Park was now just an 8 km drive, and about one km before the park boundary I realised that I was driving through a sea of pink colour on both sides of the road. It was an exciting moment, and I quickly pulled off the road to inspect the masses of *Calostemma purpureum* which surrounded me (Fig. 8, 9, 10, 11, 12). The dominant colour form was a deep pink with a whitish base but there were occasional darker almost purple flowers and distinct populations of delicate pale pink flowers. Later within the park I found a small group of plants with white flowers. I wandered through the thousands of plants and took many photographs, as past experience had told me that the *Calostemma* flowers were difficult to get in focus. I was pleased to find some mature seed which was present where the plants were flowering in shade. They were at least a week or two more mature of the vast majority of plants, and I wondered how it had occurred, there being no recorded rainfall for the area for several weeks before that of 6th and 7th of March.

I continued on, paid my park fees, and found the parking area for day visitors. Even adjacent to the parking area *Calostemma* were everywhere. I was keen to locate any *Crinum luteolum* and had noticed that there were some areas within the park that looked similar to its habitat within Pichi Richi Pass. There were a number of walking tracks within the park and while I didn't have time to walk them all, I decided to do a short distance on several of them hoping to find the *Crinum*. I had no luck but continued to see *Calostemma* everywhere. I decided it was a place to visit in the future when it would be necessary to spend a couple of days doing a full search for *Crinum luteolum*.

As I continued my journey the primary thought in my mind was whether there had been enough rainfall to induce flowering at the *Crinum*



Fig. 13 Masses of *Crinum luteolum* on steep slopes near railway bridge, Pichi Richi Pass.



Fig. 14. *Crinum luteolum*, Pichi Richi Pass.



Fig. 15. *Crinum luteolum*, Woolshed Flat, Pichi Richi Pass.



Fig. 16. Clumps of *Crinum luteolum* near railway cutting, Pichi Richi Pass.

luteolum sites I was about to visit . At Stirling North, about 8 km south of Port Augusta, I took a northerly turn and entered Pichi Richi Pass starting the 30 km journey to Quorn. The pass is followed by the old Pichi Richi railway which now runs only on special occasions, thanks to the enthusiasts who have restored the train and tracks. As I approached the first site on the pass, at the district known as Saltia, I was delighted to see a yellow haze over the gently sloping habitat. It was amazing to see hundreds and hundreds of *Crinum luteolum* in bloom. It was my fourth visit to Pichi Richi Pass, but I had only seen scattered late flowers and seed heads on previous visits. I had information suggesting there were more populations to find, so after taking plenty of photographs I continued north.

I was on the lookout for a railway bridge across the road as the next potential site, and sure enough about 200 metres before the bridge, I spotted yellow masses on the very steep cliff faces which were above the railway line. It took a short steep climb to get to the level of the railway line where I was able to get the best vantage point. The steep cliffs face in north-westerly and south-westerly directions, and there were thousands of plants in bloom all over the incredibly rocky, cliff faces (Fig. 13, 14). I was able to get close to the bottom of the north-westerly facing cliff and find plants scattered around, close to the railway line. I soon realised that it was impossible to get photographic images that demonstrated the full extent of this site.

I continued on and shortly after passing Woolshed Flat, an old railway station, I spotted *Crinum luteolum* in bloom again (Fig 15, 16). They were on a bank above and about 80 metres east of the road. Out of bloom they would have been impossible to find. Among this population I found a single plant with 12 open flowers and about six more buds beginning to open. This was the best specimen I found, and while I am sure I photographed it, I clearly missed the full extent of the flower. Digital photography in full sun is not always easy!

I continued on to a site opposite a large excavation on a cliff face made for the route of the railway line. Here quite close to the road a small knoll was dotted with flowering *Crinum*. As I looked around I noticed blooms about 80 m further along the road and soon found that this was the bottom of a gully with flowers blooming up the gully into the distance. Here I noticed there were tight clumps of *Crinum luteolum* with multiple plants in bloom. I was not sure whether this was an indication of bulb

division or just a clumps of seeds which had germinated together. Also here was an unsuccessful attempt to excavate one bulb. With bulbs about 45 cm deep in soil filled with small to quite large rocks, digging is a task which makes growing from seed very attractive. I am sure these populations will never be threatened by bulb collectors! After continuing on, and around the next corner of the road, I discovered another cliff face covered with flowering plants about 200 metres past the gully, but well back from the road.

It had been an amazing day, and as I continued I saw a small clump of flowering plants just past a second railway bridge, and then outside the entrance to the station Pichi Richi Park. The railway line was again close to the road, and just past the entrance to the station there were masses of flowering plants both sides of the railway line. I then continued on to Quorn where I had a snack and filled the car with petrol. From there I travelled north on Arden Vale Road towards sites I had previously visited and seen *Crinum* in fruit. I soon passed the turnoff to Dutchmans Stern, a strangely named bluff with recreational walks and a site I hoped to visit later in the day to look for *Calostemma*. I reached the turnoff to Warren Gorge next, finding *Crinum luteolum* in full bloom. This site had clearly had a road built right through the middle of the *Crinum* population, many decades in the past, as it had plants on both sides of the road and the adjacent grassy paddocks. A few kilometres later I arrived at the first population on Buckaringa Road. It covered a very rocky hillside with a gentle rounded slope and was an amazing site in full bloom (Fig. 17). At the second site on Buckaringa Road, the *Crinum luteolum* population was huge, by far the largest of any I saw that day. Its size is very difficult to show adequately in photographs as after the main mass of plants it continued on in small and large groups for another kilometre. While I have no inclination to the literary arts, a memory from my early school days of a Wordsworth poem repeatedly came into my head after seeing this site: “all at once I came across a host of golden daffodils”. These were not daffodils of course, but relatives as we know.

I moved on to the Buckaringa Lookout and found poorly flowering *Crinum* amongst small shrubs over the rocky mound, which was home to the lookout. This gave a view in an easterly direction to the Flinders Ranges. I was unsure whether this was a population which had less rainfall or was in decline having been overgrown by small shrubs. Continuing on

I came across the final population for the day about a kilometre further north (Fig. 18). It was in a grassy paddock and was not flowering as profusely as other sites, but was much better than the lookout. It may have also had less rain but benefited from runoff after rainfall making it more impressive than the flowering at the lookout.

After taking photographs I headed south, retracing my journey until I reached the turnoff to the Dutchmans Stern. After a 4 km drive along a narrow winding unsealed road I reached the parking area in the reserve, having passed a number of kangaroos on the way. It was 6.15pm when I arrived to discover it was an 8 km walk to cover the circuit within the reserve. Not knowing where I may encounter *Calostemma*, I decided that it was too late in the day to walk, resolving to leave exploration of this site for another day. Disappointed, I drove slowly away and soon passed a population of grass trees which I later discovered was *Xanthorrhoea quadrangulata*, the only species of this genus which grows in the Flinders Ranges floral region. A little further on I spotted some colour on the low side of the road and was delighted when I realised there were several large clumps of *Calostemma* in full bloom (Fig. 19). They were similar in colour to the main masses at Mambray Creek, having deep pink petals with a white base. I continued on and passed more *Xanthorrhoea quadrangulata* deciding to collect a little seed on this occasion. The very sharp edges of the open capsules left me with several puncture wounds on my finger tips.

I arrived at Port Augusta shortly after 7pm and was pleased to be able to check in to the same motel I had stayed at with Jim, a month earlier. I dined alone in the motel restaurant but was happy without company, as the amazing sites of the day were still fresh in my mind.

I was up early the next day and on the road soon after daylight with the 300 km trip to Andamooka my plan for the morning. Andamooka had rain just after our February trip and I hoped to collect seeds from a site of particular interest near the airstrip in the opal mining town. Jim had flowered a white *Crinum*, a little different from the desert species as we know it, which originated from near the airstrip. It took a little over 3 hours to reach the small town. It is fascinating to travel through the semi-desert habitat which changes its character at fairly regular intervals. I passed occasional salt lakes and a group of eleven Emus which were still grazing at the same site on my return trip. As on previous travels on this route I saw several wedge-tailed eagles. The last few kilometres from the

town to the airstrip was over fairly rough unsealed road which passed through large mounds of sand, excavated during past opal mining. I found *Crinum* in advanced stages of fruit production as soon as I left my vehicle. They were fairly plentiful around a small dry, sandy creek bed. The seeds were the largest I had seen on any *Crinum* this year, but there was nothing in leaf structure to suggest that this was a different *Crinum*. I searched the area thoroughly including crossing several small sand dunes near the airstrip, to an adjacent creek bed.

From the airstrip I headed to the water hole site known from my previous visits to Andamooka. I noticed *Crinum* in leaf and fruit on alternating sides of the road, over the couple of kilometres I had to travel to the water hole. It appeared to me that *Crinum* were more plentiful here than on our previous visit. Once again growth around the water hole had been delayed until the water subsided, so there were flowering desert *Crinum* (Fig. 20, 21). Most of these *Crinum* had less flowers than those seen a month earlier at Farina Creek, William Creek and Nilpinna Station, although were a deeper yellow colour. I was aware from photographs taken by our motel hosts in 2007 that there was another population of *Crinum* somewhere in Andamooka. After a short drive past the town I found another wide dry creek bed with *Crinum* in leaf growing among small shrubs and annuals. This was undoubtedly the site seen on these photographs.

With my goals achieved, I left Andamooka and stopped for lunch at Spuds Roadhouse about an hour later. The roadhouse is at the small town of Pimba, where the Andamooka road joins the Stuart Highway which transects the continent. My plan for the afternoon was to return to Port Augusta and search for *Crinum luteolum* south of the city, supposedly growing very close to the water of Spencer Gulf. After reaching Port Augusta I identified my route and headed south to find Shacks Road. This road ran parallel to Spencer Gulf 100 to 200 metres from the water and provided access to the many holiday homes or “shacks” which gave it, its name. An Australian Defence Forces exercise and live firing range occupied all the land on the other side of the road. After 7 or 8 kilometres I noticed a single small flash of colour in my peripheral vision so stopped to search.

I found 5 *Crinum luteolum* in bloom although none were particularly good specimens (Fig. 22). They were all at least 50 metres distant from each other and had only one or two smaller non-blooming plants nearby.



Fig. 17 Mass flowering on rocky slope, road to Buckaringa Lookout.



Fig. 18. Pale *Crinum luteolum* past Buckaringa Lookout.



Fig. 19. *Calostemma purpureum* near Dutchmans Stern, showing habit of growing beside buried rocks.

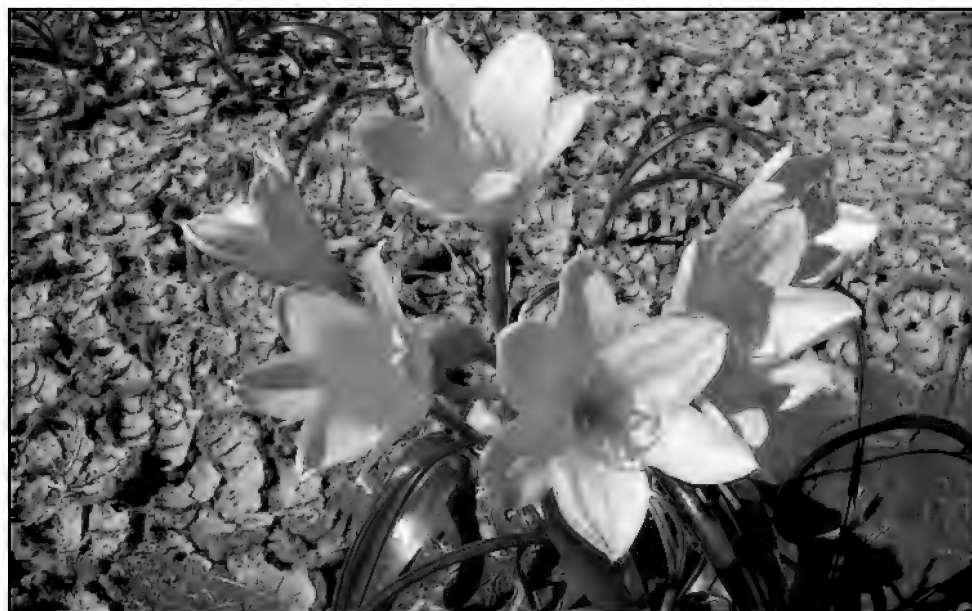


Fig. 20. Desert *Crinum* at Andamooka waterhole showing good yellow colour.



Fig. 21 Waterhole at Andamooka with *Crinum* growing in the recently flooded margins.



Fig. 22. *Crinum luteolum*, Shacks Road south of Port Augusta close to Spencer Gulf.

A search of the area failed to find any more leaves. I continued on and after another 3 kilometres I found flowering *Crinum* again. This time there was a clump of 5 *Crinum luteolum* in bloom and about 80 metres away another clump of 3 more flowering plants. Both groups were surrounded by smaller non-flowering plants, but a search of the area failed to find any further *Crinum*. It is possible this area had less rainfall and only a few *Crinum* had broken dormancy. I searched further to the end of Shacks Road but failed to find any more *Crinum*.

As it was only 4pm, I decided I had time to return to Pichi Richi Pass to search for *Calostemma*, which have been reported to be plentiful in some areas through the pass. My search was fruitless but I took more photos of the amazing mass blooming on the rocky slopes close to the first railway bridge. From there I returned to my motel and enjoyed another fine dinner in the restaurant.

On my final morning I planned to search for some *Calostemma* sites and thereby take a slightly different route back towards Adelaide. Once again I started driving shortly after 7am and after 20 or so kilometres turned in an easterly direction, heading towards the town Wilmington. From there I headed in a northerly direction on an alternative route to Quorn looking for Mt Brown Creek, a possible *Calostemma* site. I found the creek after 20 km but unfortunately it appeared to have missed the recent rainfall so the creek bed and surrounds were very dry. After returning to Wilmington I headed east again towards Orroroo with two sites in mind to investigate. The first was at the Orroroo lookout which I had visited with Jim in 2007. As the name suggests it was a raised area with *Calostemma purpureum* growing in small groups scattered around the rocky hillsides. Despite the contrasting habitat to Mambray Creek, the colour forms were very similar, although the plants were certainly not as robust on these dry hillsides. The small clumps of *Calostemma* bulbs appeared to prefer growing close to buried rock, suggesting that moisture may be more available in such sites. From there I headed south towards Peterborough looking for a population of *Xanthorrhoea quadrangulata* which was the landmark for a purple flowering *Calostemma*. After travelling about 40 km I arrived at the town without seeing the grass trees. I reviewed my directions and maps, and realised I had made a mistake and had passed the grass tree population west of Orroroo on my way into the town! I was annoyed with myself having wasted 90 minutes, which severely

dented my fairly tight schedule for the day. I found the site and discovered there was a very large area to search. After a short fruitless search I reluctantly moved on, retracing some of my morning travels.

From Wilmington I headed south towards Melrose, a known *Calostemma* site, from where there is an easterly access to the Mt Remarkable National Park. I did a short search at the entrance to the park but my morning error left me with little time. I continued south until I reached the turnoff to Germain Gorge which would lead me back to the main road heading south to Adelaide. This was a very narrow winding road with a deep gutter on the lowest side of the road to cope with flooding after rainfall. Germain Gorge is a known *Calostemma* site but my wasted time, earlier in the day, left no chance to search for plants. I did pass several attractive populations of *Xanthorrhoea quadrangulata* and managed to find a place to stop and take some photographs of this attractive species.

I reached the road back to Adelaide at Port Germain, and the drive from there to Adelaide was uneventful. As on my previous trip I was back in Hobart at about 10pm and from there it was another hour to reach home. I arrived there very tired but happy with the amazing memories from the long weekend still fresh in my mind. I have found these field trips are very addictive. With Jim and hopefully Dave Lehmler, we still have unfinished business in our Australian *Crinum* search. Potential areas of future interest include Queensland north of Cairns, and the Townsville to Rockhampton region further south. There is still an area of northern South Australia and southern Northern Territory to visit and Western Australia has vast mainly unknown potential. Let's hope there is good late summer rainfall somewhere next year.

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HYBRIDIZATION: *AMMOCHARIS*, *xCRIMOCHARIS*, *CRINUM BAUMII* AND *CYBISTETES LONGIFOLIA* (AMARYLLIDACEAE)

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INTRODUCTION

The genus *Ammocharis* was initially defined by Herbert (1821). Milne-Redhead and Schweickerdt (1939) provided a detailed history of *Ammocharis* in their treatise on *Cybistetes longifolia*, including further delineation of *Ammocharis* characters. The essential taxonomic features defining the genus included: distichous-biflabellately arranged leaves with leaves adpressed at the base (not clasping at the neck)*, older leaves growing out at the beginning of a new growing year, straight perianth tubes, and actinomorphic flowers.

DNA phylogenetic studies (Meerow & Snijman, 2001; Meerow et al., 2003; Strydom, 2005; and Kwembeya et al., 2007) have indicated the close relationship between *Ammocharis*, *Cybistetes longifolia*, and *Crinum baumii* Harms, with Kwembeya et al. proposing that *Cybistetes longifolia* and *Crinum baumii* be included within the genus *Ammocharis*. To do the latter creates a serious problem with the taxonomic definition of *Ammocharis*, since *Crinum baumii* lacks distichous-biflabellately arranged leaves (Lehmiller, 1997), and *Cybistetes longifolia* has zygomorphic flowers as well as a seed dispersal structure similar to *Brunsvigia* but bearing

Footnote: *Herbert (1837) described the leaves of *Ammocharis* as “not sheathing at the base” in contrast to *Crinum* leaves; Milne-Redhead and Schweickerdt (1939) and Lehmiller (1992a) also stressed this relationship. “Not sheathing at the base” has misled some investigators (Killick and Condry, 1994); perhaps a better descriptive term is “not clasping at the base”. In this sense, a newly-arising *Crinum* leaf is partially encircled by the preceding adjacent leaf or clasped by its predecessor at the base, whereas a newly-arising *Ammocharis* leaf is adpressed to its predecessor and not clasped; this difference is a major character to delineate *Ammocharis* from *Crinum*. The absence of clasping new leaves is essential for permitting the distichous-biflabellate pattern to form in *Ammocharis*. The term “imbricate” could be used to describe the clasping of adjacent *Crinum* leaves, but even this term might be confusing to some.

peculiar 6-ribbed fruit (Milne-Redhead & Schweickerdt, 1939; Snijman & Williamson, 1994; Lehmiller, 2007). Until more advanced DNA studies become available as well as more taxa analyzed including intergeneric hybrids, it remains best to leave *Cybistetes longifolia* as a monotypic genus and either to retain *Crinum baumii* within the genus *Crinum* or to set it aside as a separate monotypic genus.

The following account represents the author's experience with developing interspecific *Ammocharis* hybrids, intergeneric hybrids between *Ammocharis* and *Crinum* (*xCrimocharis* Lehmiller), complex hybrids, interspecific hybrids involving *Crinum baumii*, and intergeneric hybrids involving *Cybistetes longifolia* although none of the latter have yet to flower. In this account, *Crinum baumii* and *Cybistetes longifolia* are **not** considered to be *Ammocharis* (also see the discussion). All hybrid combinations are listed with the seed parent (♀) first, followed by the pollen parent (♂). An entity enclosed by brackets [...] indicates an existing hybrid bulb described in the listing.

Interspecific *Ammocharis* hybrids

1. *Ammocharis nerinoides* ♀ x *Ammocharis coranica* ♂ (Fig. 1, 2). This hybrid is clearly recognized as an *Ammocharis* by its distichous-biflabellately arranged leaves. The bulbs have been seed sterile to date. Seven bulbs have achieved flowering size, each often producing as many as 3 scapes in a growing season. No bulb has ever produced an offset.
2. *Ammocharis nerinoides* ♀ x *Ammocharis tinneana* ♂; multiple seedlings.

xCrimocharis hybrids

1. *Ammocharis nerinoides* ♀ x *Crinum lugardiae* ♂ (Fig. 3, 4). This cross was accomplished on two different occasions, with a total of 3 bulbs surviving to flowering size. *Crinum lugardiae* utilized in the parentage was the small-floral form originating from Namibia. These bulbs have been seed sterile to date. One bulb recently has produced a small offset.
2. *xCrimocharis hardyi*; *Ammocharis nerinoides* ♀ x *Crinum baumii* ♂ (Fig. 5). This particular hybrid was previously described (Lehmiller, 1999). Many flowering sized bulbs were grown from three different crosses, the clones appearing virtually identical. This hybrid has demonstrated seed fertility. One flowering size bulb of the backcross: [*Ammocharis nerinoides* ♀ x *Crinum baumii* ♂] ♀ x *Ammocharis nerinoides* ♂ has

been accomplished; its floral form bears resemblance to *Ammocharis nerinoides* (Fig. 6), and it has occasionally demonstrated seed fertility.

3. *Crinum baumii* ♀ x *Ammocharis coranica* ♂ (Fig. 7). There are 5 flowering size bulbs of this cross. Leaves are distichous but not biflabellately arranged. These bulbs are seed sterile but the pollen is viable. No offsets have ever been produced.
4. *Ammocharis nerinoides* ♀ x *Crinum venosum* ♂ (Fig. 8). The floral filaments are very short in this hybrid owing to the contribution from *Crinum venosum*. There are two flowering size bulbs, each capable of producing up to 3 scapes a season. A single bulb of the reverse cross *Crinum venosum* ♀ x *Ammocharis nerinoides* ♂ has not yet bloomed; its leaf morphology is identical to the former cross.
5. *Ammocharis coranica* ♀ x *Crinum lugardiae* ♂. Unfortunately two years ago a large bulb of this cross unexpectedly rotted when it was approaching flowering size. There are 4 remaining bulbs at the time of this writing, two of which appear to be approaching flowering size.
6. *Ammocharis nerinoides* ♀ x *Crinum modestum* ♂; one near flowering-size bulb.
7. *Crinum baumii* ♀ x *Ammocharis tinneana* ♂; one small bulb.
8. *Ammocharis nerinoides* ♀ x *Crinum hanitrae* ♂; multiple small bulbs.
9. *Crinum lugardiae* ♀ x *Ammocharis tinneana* ♂; four small bulbs.
10. *Ammocharis tinneana* ♀ x *Crinum aurantiacum* ♂; four seedlings.

Complex hybrids

1. *Ammocharis nerinoides* ♀ x [*Crinum baumii* ♀ x *Ammocharis coranica* ♂] ♂ (Fig. 9, 10). There are five flowering size bulbs from three separate successful crosses. The flowering umbels do exhibit moderate variation. No success has occurred in attempts to use these bulbs as seed parents or as pollen donors.
2. *Ammocharis tinneana* ♀ x [*Crinum baumii* ♀ x *Crinum lugardiae* ♂] ♂; multiple seedlings.

Interspecific hybrids of *Crinum baumii*

1. *Crinum baumii* ♀ x *Crinum lugardiae* ♂ (Fig. 11). Multiple blooming size bulbs have been raised from individual seeds produced from the same cross. This hybrid makes a nice potted plant. It is not seed fertile and produces scant pollen; it does slowly offset though.



Fig. 1 Interspecific hybrid; *Ammocharis nerinoides* ♀ x *Ammocharis coranica* ♂.



Fig. 2. Interspecific hybrid; *Ammocharis nerinoides* ♀ x *Ammocharis coranica* ♂. This is a different bulb than depicted in Figure 1.



Fig. 3. *xCrimocharis*; *Ammocharis nerinoides* ♀ x *Crinum lugardiae* ♂. Holotype bulb, Lehmillier 1942 (TAMU).



Fig. 4 *xCrimocharis*; *Ammocharis nerinoides* ♀ x *Crinum lugardiae* ♂. There are two flowering size bulbs growing in this 8 inch diameter pot. These are different bulbs than the holotype bulb, having been produced from a separate hybrid cross.



Fig. 5. *xCrimocharis hardyi*; *Ammocharis nerinoides* ♀ x *Crinum baumii* ♂. Multiple flowering bulbs in the same pot.



Fig. 6. [*Ammocharis nerinoides* ♀ x *Crinum baumii* ♂] ♀ x *Ammocharis nerinoides* ♂; a backcross of *xCrimocharis hardyi*.



Fig. 7. *xCrimocharis*; *Crinum baumii* ♀ x *Ammocharis coranica* ♂. Note that the leaves are distichous but not biflabellately arranged.



Fig. 8. *xCrimocharis*; *Ammocharis nerinoides* ♀ × *Crinum venosum* ♂. A scape tip has just emerged on the second bulb in this pot.



Fig. 9. Complex hybrid; *Ammocharis nerinoides* ♀ x [*Crinum baumii* ♀ x *Ammocharis coranica* ♂] ♂. There are three bulbs in the pot, with two blooming simultaneously. Note the variation in floral form.



Fig. 10. Complex hybrid; *Ammocharis nerinoides* ♀ x [*Crinum baumii* ♀ x *Ammocharis coranica* ♂] ♂. Compare to Figure 9; more variation in floral form. Note the leaves are distichous but not biflabellately arranged.



Fig. 11. Interspecific hybrid; *Crinum baumii* ♀ × *Crinum lugardiae* ♂.



Fig. 12. Interspecific hybrid flower; *Crinum baumii* ♀ x *Crinum forbesii* ♂.

2. *Crinum baumii* ♀ x *Crinum forbesii* ♂ (Fig. 12). One flowering size bulb exists. It produces showy striped flowers, with umbels ranging from 1 to 7 flowers.

Intergeneric hybrids involving *Cybistetes longifolia* (unflowered)

1. *Crinum baumii* ♀ x *Cybistetes longifolia* ♂; two small bulbs.
2. *Cybistetes longifolia* ♀ x *Ammocharis tinneana* ♂; two seedlings.
3. *Cybistetes longifolia* ♀ x *Ammocharis nerinoides* ♂; multiple seedlings.
The reverse cross *Ammocharis nerinoides* ♀ x *Cybistetes longifolia* ♂; multiple seedlings.
4. *Crinum mccoysi* ♀ x *Cybistetes longifolia* ♂; three seedlings.
5. *Cybistetes longifolia* ♀ x [*Ammocharis nerinoides* ♀ x *Ammocharis coranica* ♂] ♂; two seedlings.
6. [*xCrinumocharis hardyi* ♀ x *Ammocharis nerinoides* ♂] ♀ x *Cybistetes longifolia* ♂; four seedlings.

DISCUSSION

Crinum baumii (Fig. 13) became a controversial taxon following its discovery since most investigators only had herbarium specimens to

study. It was not introduced into general cultivation until the mid 1990s following a collection in the Mahango Game Reserve of Namibia in 1989 (Lehmiller, 1992b). As can be seen in Fig. 13, it has an actinomorphic flower typical of subgenus *Crinum* (subgenus *Stenaster*), but the perianth tube does not exhibit drooping or inclining motion prior to anthesis, an aberrant feature for *Crinum*. Its leaves tend to be erect until they become long, but they are so narrow that it is impossible to determine if they exhibit clasping or sheathing at the base; most certainly the leaves are neither distichous nor biflabellately arranged. Additionally, mature leaves are channeled, another feature against a morphologic classification of *Ammocharis*.

In the hybrid *Crinum baumii* ♀ x *Ammocharis coranica* ♂, leaves are distichous but not biflabellately arranged; similarly, the complex hybrid *Ammocharis nerinoides* ♀ x [*Crinum baumii* ♀ x *Ammocharis coranica* ♂] ♂ has distichous leaves that are not biflabellately arranged. So in intergeneric hybridization with *Ammocharis*, *Crinum baumii* does not impart distichous-biflabellately arranged leaves.

Regarding taxonomy, the morphology of *Crinum baumii* falls somewhere in between *Crinum* and *Ammocharis*. However, since it has channeled leaves that lack an adpressed, distichous-biflabellately arrangement, it should remain within *Crinum* or be assigned the status of a monotypic genus.

Reasons for keeping *Cybistetes longifolia* as a monotypic genus have been discussed previously (Lehmiller, 2007).

All photographs by the author.

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Fig. 13. *Crinum baumii*. The leaves are neither distichous nor biflabellately arranged. The two parallel leaves at 9° Clock on the flowering bulb are channeled (you may require a magnifying lens to observe the leaf channels).

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CLEISTOGAMY¹ IN *PROTOTULBAGHIA SIEBERTII* VOSA (ALLIACEAE)

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Since the first descriptive article by Vosa (2007), *Prototulbaghia siebertii* has been the subject of a number of articles illustrating its unique habitat (Siebert et al., 2008) as well as some interesting morphological features relating to the presence of glandular hairs and other excrescences on the flowering stems and leaves (Vosa et al., 2011a, b). These features seem to be peculiar of the species and have not been found all together in other genera of the family Alliaceae.

The following note concerns the results of breeding and cultivation experiments as well as of embryological studies carried out in order to further the knowledge of the evolutionary position of the genus *Prototulbaghia* among some other genera of its family.

By courtesy of Martin Smit, Curator of the Botanic Garden of the North-West University, Potchefstroom, South Africa, I have had the chance of observing and studying *in vivo* plants of *Prototulbaghia* in cultivation in the Botanic Garden of the University of Pisa, Tuscany, Northern Italy. These plants were part of an original collection in *locus classicus* by Dr. Stefan Siebert of the North-West University in April 2008. The study as a whole has included about 25 other living plants of *Prototulbaghia*, some of which were raised from seeds as well as some derived from collections in the wild.

Prototulbaghia siebertii is a very small mountain plant. It grows in a unique habitat of seepage areas mostly at the edges of norite rock-sheets on the summit of the Leolo Mountains at more than 1800 m of altitude

Footnote ¹: Cleistogamy is a form of specialized reproduction involving self-pollinated flowers which are less conspicuous than normal flowers; these flowers do not open normally and thus prohibit cross pollination from occurring.

in Sekhukhuneland, Limpopo Province, South Africa (Vosa, 2007; Siebert et al., 2008; Vosa et al., 2011a, b). Sekhukhuneland is one of the important regions of floristic endemism in Southern Africa (Van Wyk and Smith, 2001).

Cultivation experiments have shown that the species grows and flowers well at room temperature in a practically water-saturated compost of ordinary garden soil mixed 3:1 with grit and fine river sand at about neutral pH.

As observed in cultivation, after an almost non-vegetative resting period of about 4-5 months, *P. siebertii* starts to grow and flowers at the beginning of warmer weather and longer daylight which coincide with the rainy season in its original habitat and of late spring to early summer in Southern Europe.

The species flowers continuously almost throughout its growing period. The inflorescences consist of 3-10 flowers which open in succession, 1-3 at a time, over a period of about 10-12 days. Each flower remains open about 10 hours and occasionally longer in cooler weather.

In the absence of cross-fertilization the flowers wither and, after a while, most detach themselves neatly from the pedicels due probably to an abscission layer at their base (Fig. 1).

At anthesis, the pedicels are about 20 to 25 mm long, but it has been noticed that ever so often, in some inflorescences, one or more of the pedicels appear rather shorter (10 to 15 mm long or less) and carry somewhat squatter flower buds. These buds do not develop normally or open but somewhat swell and split quite soon, showing apparently normal developing seed capsules (Fig. 1). Such capsules soon become scarious, open loculicidally and release the seeds in about 10-15 days.

The number of seeds in these clearly cleistogamic seed capsules is the same as in normal capsules and is about six. Generally, the seeds germinate within a week at room temperature (20 to 25° C) in rather moist sandy compost, and the resulting plantlets are strong and relatively fast growing (Fig. 3).

Visual analysis of plants *in situ*, as well as careful perusal of a fairly large number of plants in cultivation and of the available herbarium specimens has shown the presence of many well developed and ripening seed capsules and has lead to the hypothesis of some degree of self-fertility in *Prototulbaghia* (Vosa, 2007). However, controlled pollination



Fig. 1 Inflorescence of *Prototulbaghia* showing a short pedicel carrying a green ripening seed capsule. There are three open flowers and a number of pedicels from which the non-fertilized flowers have withered and fallen off. Photograph by C.G.Vosa.



Fig. 2. Inflorescence of *Prototulbaghia* showing the effect of cross-pollination. Most of the faded flowers show developing seed capsules. Interestingly, note towards the bottom of the inflorescence a developing short-pedicelled, presumably cleistogamic bud. Photograph by C.G.Vosa.

Fig. 3. Seedlings of *Prototulbaghia* from a cleistogamic capsule after about two weeks following germination. Note the remains of the seed testa at the top of the cotyledon leaf and the reddish colour of the lower parts of the true leaves. Photograph by C.G.Vosa.



Fig. 4. This photograph shows two typical chasmogamic flowers in *Prototulbaghia siebertii*. Note upper left a still developing flower and lower right a fully expanded flower with just dehiscent anthers. The juxtaposition of the sexual elements with the anthers and the stigma more or less at the same level is evident as well as the structure of the pseudocorona. Photograph by Dirk Wallace, slightly modified from Vosa, 2007.

experiments, carried out over two flowering seasons, on about twenty plants from at least two locations, have shown that the species seems to be almost entirely self-incompatible. Self-pollinated flowers fade, wither normally and mostly fall off the pedicels (Fig. 1).

Just after fading, the ovary of cross-pollinated flowers begins to swell and soon shows the characteristic mitre-shaped seed-capsule (Fig. 2).

Thus, we can state that in *Prototulbaghia* there exists a process of cleistogamy. This process can be considered developmental involving dimorphic chasmogamic (Fig. 4) and cleistogamic flowers (Fig. 1), and it involves the precocious development and dehiscence of the anthers. Further, it must include, necessarily, the breakdown of self-incompatibility.

Dimorphic chasmogamic and cleistogamic flowers have been reported in at least another member of the family Alliaceae, namely *Allium stellatum* Ker-Gawl from North America (Molano-Flores *et al.*, 1999).

A well compiled and exhaustive review of cleistogamous breeding systems in angiosperms has been published recently (Culley and Klooster, 2007).

Preliminary embryological studies in both genera *Prototulbaghia* and *Tulbaghia* have established the existence of an embryo-sac formation of the *Allium* type, resulting in a triploid endosperm (Battaglia, 1958). This clearly supports the hypothesis of the probable close evolutionary relationship between *Allium*, *Tulbaghia* and *Prototulbaghia*.

In conclusion, the present findings show that in *Prototulbaghia* normal fertility may indeed be compounded and enhanced by the existence of a form of cleistogamy.

Considering its unique habitat and rather isolated condition as a genus, it is interesting to note that besides the peculiar hooked leaf-tips (see Vosa, 2007; Vosa *et al.*, 2011a, b), yet another special feature, namely cleistogamy, essentially concurs to ensure successful reproduction in *Prototulbaghia*.

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NARCISSUS – A FRAGRANT BULBOUS PLANT

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INTRODUCTION

Narcissus is a bulbous crop and belongs to family Amaryllidaceae. The word *Narcissus* is derived from the Greek word *narke*, meaning numbness or stupor. *Narcissus* was named after the legendary Greek youth *Narcissus* who was strikingly handsome and vain; he became so obsessed with his reflection in a pool that he could not leave and subsequently died. The Greeks say that the gods turned his remains into the *Narcissus* flower. Some attribute the naming of the flower to its narcotic fragrance while others debate that it is associated with the poisonous nature of the *Narcissus* bulbs. It is one of the important flowers in the world and the most popular flower in Germany. This plant is native to the Mediterranean region, but a few species are found through central Asia to China. The most common *Narcissus* species found growing throughout America today were brought over from Europe by the early colonists and distributed westward by settlers from the East. *Narcissus* is mainly cultivated in the Channel Isles, the Isles of Sicily, Great Britain and Holland. Blooming period of *Narcissus* is from November to April depending on the species. The typical Daffodil blooms in the early spring.

Mostly a spring-flowering bulb, *Narcissus* is the name of a genus which includes flower bulbs like Daffodils, Jonquils, Paper Whites and so forth. *Narcissus* are easily grown from bulbs. *Narcissus* flowers are usually white or yellow and are characterized by a narrow, tubular base (hypanthium), three petals and three petal-like sepals (the perianth), and a central cuplike appendage (the corona, cup, or crown) that may be of contrasting colors. The seeds are black, round and swollen with a hard coating. There are also several *Narcissus* species that bloom in the autumn. Though *Hortus Third* cites 26 wild species, *Daffodils for North American Gardens* cites between 50 and 100 excluding species variants and wild hybrids. Through taxonomic and genetic research, it is speculated that over time this number

will probably continue to be refined. Daffodil is a common English name, sometimes used now for all varieties, and is the chief common name of horticultural prevalence used by the American Daffodil Society.

The range of forms in cultivation has been heavily modified and extended, with new variations available from specialists almost every year. Though the traditional Daffodil of folklore, poetry, and field may have a yellow to golden-yellow color all over, both in the wild species and due to breeding, the perianth and corona may be variously colored. Breeders have developed some Daffodils with double, triple, or ambiguously multiple rows and layers of segments, and several wild species also have known double variants.

NARCISSUS VARIETIES

The genus *Narcissus* encompasses dozens of species, hybrids, varieties and forms. Jonquils, Daffodils, and Paper Whites are the most popular varieties of *Narcissus*.

Jonquils: They have dark green, round, rush-like leaves and a cluster of small, fragrant, early, yellow blossoms.

Daffodils: Without a doubt, modern large flowered Daffodils are the most popular type of *Narcissus* planted today.

Paper Whites: As the name suggests, Paper Whites are white. But, one can find these trumpet shaped flowers in yellow too. Plants have heavy scented, white trumpeted flowers. It can be easily grown. It is a native to Europe and Asia and now grown around the world. Paper Whites are a small member of the *Narcissus* family (Daffodils and Jonquils are larger family members). Paper Whites are popular due to their small-size flowers loaded with fragrance and charm.

The American Daffodil Society (ADS): ADS divides all *Narcissus* into 13 horticultural divisions, based partly upon flower form and partly upon genetic background. Since the ADS Web site is written for general consumption, the text of the descriptions contained there is relatively broad. Horticulturist Robert F. Gabella of Garden Opus has further clarified herein these definitions by replacement of the words “cup” with “corona”, “petals” with “perianth segments”, and clarified corona length and corona radius for cases where the corona does not protrude outward. Gabella has further emphasized the prevalence of species phenotype comparable to the genetic lineage of ADS Divisions 5 through 10, and has also called out garden and/or wild origin.

CULTIVATION AND INTERCULTURAL PRACTICES

Bulbs are the main source of propagation for growing all the species of *Narcissus*. *Narcissus* bulbs are very easy to grow. *Narcissus* requires little maintenance. Still, if you would take some minimum care, *Narcissus* can be more vigorous and floriferous, and they'll multiply much more quickly, improving the show they provide each year.

Soil & Site Selection: *Narcissus* grow almost anywhere, although it does prefer well-drained soils with a sunny or light shade environment. The *Narcissus* species types are more specific in their requirements.

Planting Bulbs: *Narcissus* should be planted from August to November, the earlier the better, at a depth three times the height of the bulb in beds, borders and large containers. In lawns, *Narcissus* is best planted slightly deeper, at a depth of 15cm.

Planting Associations: *Narcissus* looks good planted in borders or in naturalized drifts at the base of deciduous trees. *Narcissus* looks its best when planted in drifts of eight or more bulbs, which appears more natural.

Deadheading: When *Narcissus* flower-heads have faded, it is best to remove them. Otherwise the plant will divert energy from building up the bulb, which is necessary for next year's display, and put it into seed production.

Post-Flowering Care: After the *Narcissus* blooms have faded, the remaining leaves can look unsightly as they turn yellow. It is important to resist the temptation of removing this foliage early. It contains valuable nutrients that will be used for next year's crop of flowers. Do not remove the leaves for at least six weeks after flowering - longer if possible - before removing them.

Propagation: Divide overcrowded *Narcissus* clumps in late summer, and plant offsets elsewhere in the garden. The *Narcissus* species types can be propagated with fresh seed collected during summer and sown in late summer or autumn in pots outdoors.

NARCISSUS PLANT CARE

Like most perennials, *Narcissus* does well with about 1 inch of water per week while they're actively growing and blooming - from March to May. Mulch can be tremendously helpful in conserving moisture in *Narcissus* plants. The best thing you can do for your *Narcissus* bulbs is provide them rich, well-drained soil with lots of organic matter in it. Most organic bulb fertilizers can be placed right into the planting hole because they're very gentle and non-burning.

Since *Narcissus* is a perennial, every 5 to 10 years, divide the clumps of bulbs in early summer. Once flowers are produced, it is best to keep plants away from direct sunlight and in a cool area. This will prolong the flowering period in *Narcissus*.

TOXICITY

All *Narcissus* varieties contain the alkaloid poison lycorine, mostly in the bulb but also in the leaves. On May 1, 2009 a number of school children fell ill at Gorseland Primary School in Martlesham Heath, Suffolk, England after adding a Daffodil bulb to soup during a cookery class. The bulbs could often be confused with onions, thereby leading to incidents of accidental poisoning.

MEDICINE

In *kampo* (traditional Japanese medicine), wounds were treated with narcissus root and wheat flour paste, though it does not appear in the modern *kampo* herb list. The Roman physician Aulus Cornelius Celsus listed narcissus root in *De Medicina* among medical herbs, described as emollient, erodent, and “powerful to disperse whatever has collected in any part of the body”. In one scientific study, the ethanol extract of the bulbs was found effective in one mouse model of nociception, para-benzoquinone induced abdominal constriction, but not in another, the hot plate test.

One of the most common dermatitis problems for florists, “daffodil itch” involves dryness, fissures, scaling, and erythema in the hands, often accompanied by subungual hyperkeratosis (thickening of the skin beneath the nails). It is blamed on exposure to calcium oxalate in the sap.

CULTURAL IMPORTANCE

The *Narcissus* flower is perceived quite differently in the East than in the West. Whereas in the West the *Narcissus* flower is seen as a symbol of vanity, in China the same flower is seen as a symbol of wealth and good fortune. In ancient China, there is a legend about a poor but good man, who was brought many cups of gold and wealth by this flower. Since the flower blooms around the first of the year, it has also become a symbol of Chinese New Year. *Narcissus* bulb carving and cultivation is even an art akin to Japanese Bonsai. If your *Narcissus* blooms on Chinese New Years, it is said to bring you extra wealth and good fortune throughout the

upcoming year. On top of that, it has one of the sweetest fragrances of any flower. So it is highly revered in Chinese culture.

DATA COLLECTION

Morphological data has been recorded, compiled, tabulated and statistically analyzed for *Narcissus papyraceus* bulbs (Fig. 1) cultivated under Lucknow climatic conditions and it has been listed in Table-1.



Fig.1. Narcissus plant: (A) Bud development inside the sheath
(B) Emergence of buds from the inflorescence
(C) Close up view of flowers on inflorescence

Table 1. Vegetative and floral characters of *Narcissus* cv. *Narcissus papyraceus* under Lucknow climatic conditions.

Size of bulbs	Height	(cm) \pm SE	6.07 \pm 0.12
	Diameter	(cm) \pm SE	3.90 \pm 0.19
	Weight	(gm) \pm SE	32.42 \pm 2.64
Days to sprout		Days \pm SE	15.56 \pm 0.62
Number of sprout		Days \pm SE	4.76 \pm 0.39
Height of plants		(cm) \pm SE	29.90 \pm 0.72
Number of leaves			15-24
Size of leaves	Length	(cm) \pm SE	37.05 \pm 0.67
	Width	(cm) \pm SE	1.60 \pm 0.04
Days to bud initiation		Days \pm SE	39.40 \pm 0.66
Days to first color shown		Days \pm SE	50.40 \pm 0.58
Days to full bloom		Days \pm SE	53.40 \pm 0.49
Weight of flower with pedicel		(gm) \pm SE	0.45 \pm 0.03
Length of pedicel		(cm) \pm SE	2.77 \pm 0.07
Tube length		(cm) \pm SE	1.69 \pm 0.02
Number of petals	Outer		3
	Inner		3
Number of stamens			3
Size of petal	Length	(cm) \pm SE	1.94 \pm 0.05
	Width	(cm) \pm SE	1.30 \pm 0.08
Size of flower	Height	(cm) \pm SE	1.05 \pm 0.01
	Across	(cm) \pm SE	3.82 \pm 0.12
Number of flowers/plant			9-12
Size of pollen	Length	(μ m) \pm SE	38.60 \pm 1.85
	Width	(μ m) \pm SE	22.10 \pm 1.53
Number of pollen		(mm ²) \pm SE	865.80 \pm 76.97
Color of bulb			Grayed – Orange group 164A fan-4 Grayed – Orange group 166A fan-4
Color of flower			White group 155D fan-4
Color of pedicel			Yellow - Green group 144B fan-3
Color of ovary			Green group 137A fan-3
Color of pollen tube			Yellow - Green group 144C fan-3
Color of stamen			Yellow group 13A fan-1
Color of stigma			Green - White group 157A fan-4

FRITILLARIA NOTES

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INTRODUCTION

In 1966 I organised the third of my plant hunting explorations based principally on Turkey (Watson, 1971). The late Martyn Cheese supported me throughout as main collecting partner. Four others accompanied us intermittently. We travelled in up to two landrovers. As our first major, serious project of the kind, it was constantly productive between March and September. Its success encouraged us to continue over into the following season.

Five of the species encountered later turned out to be undescribed for science. The spectacular difference of one from all others of its genus left us in no doubt of its novelty on the spot. As our eyes adjusted to the glare we picked it out subtly bejewelling the pale, saturated gravel surrounding a high, late snowdrift. That was the glorious 'Pink Frit', *Fritillaria alburyana* Rix, named in memory of our third principle collector, Sydney Albury. He had died of high altitude edema shortly afterwards while searching for plants in Nepal (Watson & Rix, 1970; Rix, 1984; Watson, 2008).

But the small handful of new species represented no more than icing on a very rich cake of botanical voucher specimens, photographic images and material for trial in cultivation. It so happens at times during these periods of field exploration – quixotically and without deliberate planning – that one or two major desirable genera rise like cream to the top in more prolific numbers than would seem logical. In that vein this turned out to be our big year for *Iris* sect. *Oncocyclus* ... and *Fritillaria* ..., never again to be matched by us for either.

THE INCREDIBLE SHRINKING FRIT

The Kurdish mountain Halkis Dağ of Siirt Province stands out as one of our most memorable sites (Watson, 1971) (Fig. 1). What it lacked in rich diversity of taxa, as encountered on some of our other favourite Turkish heights, it handsomely compensated for in the sheer quality of its fewer

denizens. Ground orchids were particularly rich around the base, notably species of *Ophrys* which mimic insects, but also a striking lizard orchid (Fig 2, 3). Its boulder-strewn upper limestone dome, garnished with a dense, verdant filigree carpet of wild fennel interspersed with graceful, waving grasses, was punctuated liberally by the most spectacular clumps of the beauty W.R. Dykes dubbed 'The Prince of Irises' (Archibald, 1999), *Iris gatesii* Foster (Fig. 4). These absurdly over-sized confections displayed a range of form, subtle coloration and pattern exceeding any previously known for the species. Tragically, we learn that following its whereabouts being made known publicly in the interests of botanical science (but not by ourselves), it appears to have been dug up, perhaps to the last plant (John Andrews, pers. comm.). *Iris gatesii* is terminally intractable in general cultivation. The spoils presumably ended in the hands of unscrupulous nursery traders and shortly afterwards expired following unskilled treatment by sadly ignorant customers.

Slanting between the mountain's base and upper dome was a steep slope of alternating rocky outcrops and unstable mudstone and limestone screes, often at distinctly uneasy angles of repose. A very thin scattering of short-lived herbs brightened these. They included shot-silk orange poppies, imperial violet campanulas, and yellow love-in-the-mist. By the time we arrived, nearing the end of May, any bulbs had long finished flowering, but several offered welcome ripe seed. Stately *Fritillaria imperialis* L., not far short of 1 m tall, must look truly spectacular there in its due season. One of us with extra-sharp eyesight spotted solitary fruits of another *Fritillaria*, also bulging with seeds, on nearby mobile scree at 1300 m. This one, the ultimate antithesis of *F. imperialis*, scarcely if at all exceeded 3-4 cm in height. Truly the long and short of it!

Sydney Albury, its first 'Gulliver', germinated, raised and flowered this diminutive Lillputian, known by our collectors' reference datum as AC&W 1192, while we were away for our second consecutive season in Turkey the next year (Fig. 5). In his photograph it barely overtopped the small obsolete British sixpenny piece (19 mm dia.) he placed discreetly behind to indicate the scale. That great amateur plant explorer, botanical painter and plantsman, Admiral Paul Furse, described it as '... like a tiny *F. armena* sticking its tongue out.' (Watson, 1971). Despite dramatically reduced stem and foliage, the tepals shaped into an exact miniature of *Fritillaria armena* Boiss. in form and colour (Fig. 6); tubular bell-shaped, flaring slightly at



Fig. 1. View of the Kurdish Taurus in Siirt Province, Turkey, from the limestone top of Halkis Dağ, above the fritillary screes. May 21, 1966.



Fig. 2. *Ophrys straussii* (AC&W 1239), an extremely handsome bee orchid, in the meadows of the approach to Halkis Dağ, Siirt Province, Turkey. May 22, 1966.



Fig. 3. *Himantoglossum affine* (AC&W 1244), a rare lizard orchid, in the meadows of the approach to Halkis Dağ, Siirt Province, Turkey. May 22, 1966.



Fig. 4. *Iris gatesii* (AC&W 1230), the crowning glory of the sunken limestone dome forming the Halkis Dağ summit. Siirt Province, Turkey. May 21, 1966.

the mouth, and a very dark plum-purple, somewhat bloomed without. It differed in the uncharacteristically short perigone, which left the style and stamens exserted.

In our naïve enthusiasm of those days we nurtured high hopes that such an utterly distinct-looking taxon might join *F. alburyana* in proving new to science. However, when the leading authority on the genus, Martyn Rix, came to enter it soberly in Volume 8 of *Flora of Turkey* (Rix, op. cit.), he listed it under *F. armena* with the following observation: ‘The collection from B8 Siirt (Watson et al. 1192) is unusual in having very short stems, perianth segments, and protruding style.’ Interestingly, he then continued: ‘A collection from B7 Elaziğ (Haroğlu Da., Kuzey yamaç, 2000 m, Evren 618!) is very dwarf, and unusual in its slender papillose style and filaments, both exceeding the perianth.’

Martyn Rix (in litt.) has provided me with the following additional details this year. Apparently the Furse plant was somewhat taller, to 7 cm, perhaps as a result of being recorded at a later stage of flowering than Albury’s. The leaves were also flat to the ground and greyish, rather than erect and greenish or greenish glaucous, as is typical for the species, and as can be seen in Sydney Albury’s photograph. Martyn also reported having seen two more original specimens raised by another private bulb specialist, and one at the Royal Horticultural Society’s gardens, Wisley. He did not provide descriptions of these. However, it would seem from his report that the population may perhaps be somewhat variable, in foliage characters if nothing else.

So we know AC&W 1192 was raised and flowered by at least four growers. Are any living plants in fact still in circulation anywhere after all this time?

REOPENING THE CASEBOOK

As part of an occasional ongoing series of retrospective accounts focussing in particular on our Turkish floristic explorations during the 60s, which were rounded off by a final sortie in 1977, I wrote of various memorable encounters we had registered with species of the genus *Aristolochia* (Watson, 2010a, 2010b). One such occurred at the base of Halkis Dağ, and offered the opportunity for some incidental renewed coverage of the mountain’s flora, accompanied this time by the advantage of images in colour.



Fig. 5 ...and the short of it. "... tiny ... with its tongue sticking out". AC&W 1192

Fritillaria aff. *armena* as grown in cultivation by one of its collectors, Sydney Albury, from a few bulbs he dug out of the Halkis Dağ screes at 1300 m on May 20, 1966 and brought back to Britain. Provenance: Siirt Province, Turkey. Original photograph 1967 by S.D. Albury, digitally remastered by J.M. Watson.

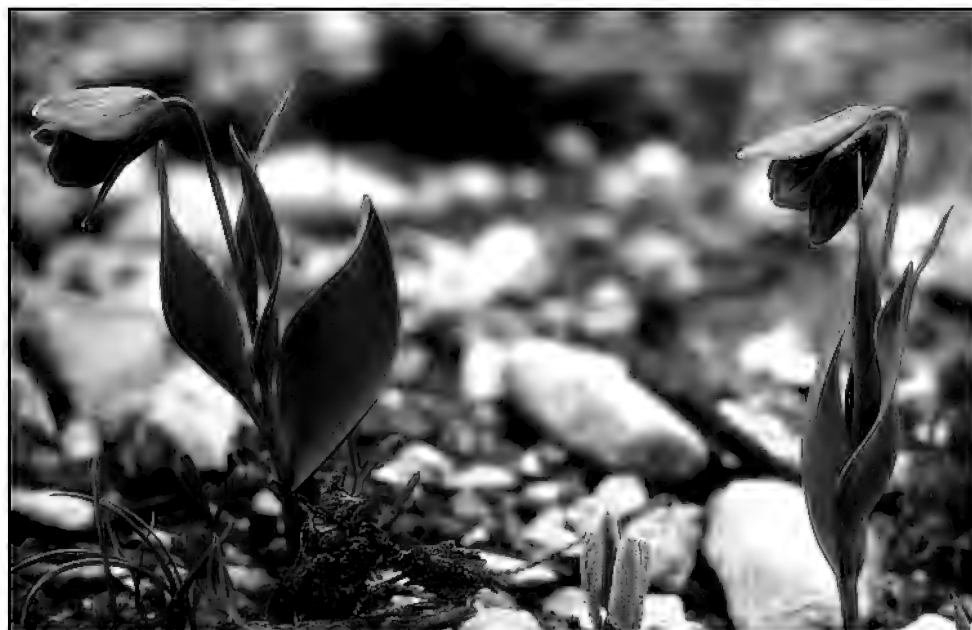


Fig. 6. *Fritillaria armena* (CM&W 2756A) for comparison. Erzurum Province at 2250 m. Turkey. June 20, 1967.

Among plants featured was our dwarf *F. armena*. My prepared text was copied to Martyn Rix in case any second thoughts or other developments had arisen since Flora of Turkey. As a result, he drew my attention to another interesting relevant fritillary:

‘There is a recent description of a new species from E Turkey, *F. baskilensis*, described as a *caucasica*-like plant with a protruding style, so that is a further complication.’ (E.M. Rix, in litt.)

Searching out details on the Internet, I found a generous selection of references to *Fritillaria baskilensis* Behçet (1998) and two photographic images by its same Turkish collector and author. Both are of uprooted plants. One is freshly dug, the leaves greyish. The other shows two herbarium specimens with flowers. One pressed perigone appears to be ‘*caucasica*-shaped’, the other ‘*armena*-shaped’. The perigone of the live specimen is quite tubby and also resembles *F. armena* more closely. The style and stamens protrude in every case. However they also do so in a photograph of a large wild clump identified as *Fritillaria caucasica* J.F. Adam, but which is clearly *F. armena* (Demirkuş, 2006). The specimens in the photographs by Behçet do not look at all dwarf.

I am indebted to Martyn Rix for having supplied further authoritative information, as follows during our subsequent exchanges:

‘I am a bit suspicious of *F. baskilensis*; styles can be pushed out of the flower as the ovary elongates after pollination, and if the plant is otherwise similar to *F. caucasica*, it should be a var. of that, ... at best.’

‘There are so many odd forms in the *pinardii* group that I have not described anything, but I expect some splitters will coin more new names. Some, I am sure, are hybrid swarms!’ (E.M. Rix, in litt.)

The basically tubular *F. armena* perigone has rather ‘square shoulders’ and an almost constant diameter before flaring open somewhat at the tips. That of *F. caucasica* also flares, but its profile is notably more gently rounded, increasing gradually from the base and sometimes imperceptibly waisting before the final out-curving of the tepals (Fig. 7).

From a relevant up-to-date Turkish pollen study: ‘The taxonomy of some species, such as *F. baskilensis* and *F. pinardii*, is problematic. Because the vegetative characters are very variable, species identification is difficult. The sculpturing of the pollen exine is a valuable character for separating between *F. baskilensis* (suprareticulate) and *F. pinardii* (reticulate-perforate)’ (Tek en et al., 2010). Unfortunately this does not present us



Fig. 7. *Fritillaria caucasica* (AC&W 1659) for comparison. Çakmak Dağ, Erzurum Province, Turkey at 2900 m. June 21, 1966.

with an unambiguously clear-cut picture. Their work is without doubt fully comprehensive (for themselves) in terms of Turkish mainland taxa. They sampled 31 of the 34 treated in Flora of Turkey as well as 8 more described subsequently; 39 in total. *F. armena*, *Fritillaria viridiflora* Post and *Fritillaria zagrica* Stapf are in the Flora but absent from their study. However, they cite 39 taxa as their total for Turkey, so unquestionably consider the three ‘missing’ names to be synonyms. We are therefore faced – as here – by the unfortunate consequent dilemma that synonymy may not be provided in this type of context. *Fritillaria pinardii* is the closest relative of *F. armena*, so at best we can only reasonably assume that must be their accepted epithet. If indeed so, we next arrive at the unsatisfactory situation of insufficient sampling and all the errors that may induce. Each taxon in their survey was represented by one gathering only. Their collection of *F. pinardii* was from C6 Kahramanmara in the Antitaurus of central southern Anatolia. This is in the heart of *F. pinardii* distribution as recognised in Flora of Turkey, but distinctly south of any locality recorded in the same work for *F. armena*. Furthermore, no hybrids or material corresponding geographically to AC&W 1192 were sampled for pollen.

A LITTLE LEARNING IS A DANG’ROUS THING

Drink deep, or taste not the Linnean* spring ...
 But more advanc’d, (we) behold with strange surprize
 New distant scenes of endless science rise!
 So pleas’d at first the tow’ring Alps we try,
 Mount o’er the vales and seem to tread the sky,
 Th’ eternal snows appear already past,
 And the first clouds and mountains seem the last:
 But, those attain’d, we tremble to survey
 The growing labours of the lengthen’d way,
 Th’ increasing prospect tires our wand’ring eyes,
 Hills peep o’er hills and Alps on Alps arise! (Pope, 1711)
 (*Scientific licence! The actual word is ‘Pierian’)

It seems likely we are in the presence here of what may be recognised as the advanced stage of a classic, progressive, geotaxonomical syndrome. The apposite extracted heroic couplets above encapsulate it effectively, their metaphors working almost literally for us! Pioneering botanical

exploration of any region tends to yield a basic, satisfyingly well-defined core selection of seemingly quite distinct taxa from significant genera. These represent distanced initial sampling over a wide area. In time ever more collections are added from intervening terrain, while original sites may also be re-examined more thoroughly. As a result the water can become ever muddier. Discontinuities break down. Anomalous populations and specimens are discovered which upset existing neat patterns. Modern laboratory analyses exacerbate this tendency greatly. After all, how do we ‘read’ pollen in situ? Inter alia we find ourselves in the presence of ‘messy’ clines, confusing heteromorphism, convergence, and sympatric or reticulate hybridisation in action – perhaps with one or all original parents missing.

As well as *Fritillaria* here, that pattern also applies to several of our own particular major areas of study or interest in South America: complexes of *Alstroemeria*, *Leucocoryne* and *Viola* as well as some Amaryllidaceae, for example. Without doubt specialist readers could add many more groups.

To return to *Fritillaria*, various references exist of both natural and artificial hybrids, but in his excellent photographic guide to the bulbous plants of Turkey and Iran, Peter Sheasby (2007) presents an image of a remarkable wild cross between *F. alburyana* and *F. armena*. This well illustrates both the tendency of certain groups within the genus to hybridise, as surmised by Rix above, and also the increasing discovery of confusing intermediates of one kind or another over time. Like Admiral Furse’s little fritillary, Mother Nature is much inclined to stick her tongue out too, mocking our scientific pretensions.

SURVIVAL OF THE LEASTEST

As a closing thought, being a rare, showy, easily dug and handily transported plant, which is highly attractive to humans and hence irresistible commercially, has become a very recent negative factor in the Darwinian survival equation. At least the extreme inconspicuousness in situ of AC&W 1192 relieved us of the all-too-prescient environmental anxiety and responsibility which we faced in the aftermath of our almost simultaneous discovery of desperately vulnerable *Iris gatesii*!

All photographs by the author except where indicated

NOTE REGARDING FIGURES:

Most photographic captions contain details regarding collectors and specimen collection numbers; the latter have been abbreviated, using the following key:

AC&W = Albury, Cheese & Watson, 1966.

CM&W = Cheese, Mitchell & Watson, 1967.

ACKNOWLEDGEMENTS

Without the invaluable generous and expert input by Martyn Rix, this note would be non-existent.

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**AN IMPORTANT AND UNUSUAL DISTRIBUTION
EXTENSION FOR THE CHILEAN *ALSTROEMERIA
PHILIPPII* BAKER SUBSP. *ADRIANAE* J.M. WATSON & A.R.
FLORES (*ALSTROEMERIACEAE*)**

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DISCUSSION

Late in 2009 we were kindly presented by Dr. Francisco Squeo of La Serena University with a copy of the book 'Flora y Vegetación de la Reserva Nacional Pingüino de Humboldt' (The Flora and Vegetation of the Humboldt Penguin National Nature Reserve) (Arancio & Jara, 2007). This reserve in Chile consists entirely of three small offshore Pacific islands in the regions of Atacama and Coquimbo. They cover a combined N-S span of ca 29 km and are situated approximately 7 km from the coast.

For the vascular plant survey undertaken to provide information for their publication, its authors visited the islands two years apart during the high spring flowering time of the adjacent mainland. On the first occasion, 2000, a season of scarce, below average rainfall, they encountered little but persistent woody shrubs and cacti. By contrast, a remarkable abundance and diversity of more ephemeral annual or hidden-dormant flora was seen in 2002, following a winter and early spring of much heavier rainfall. 58 species of vascular plants from 44 genera and 28 families were recorded (Arancio & Jara, 2007), all elements of the so-called Flowering Desert of the adjacent mainland, and the identical taxa. Among them were three overall common geophytic petaloid monocots, *Alstroemeria philippii* Baker s.l. (*Alstroemeriaceae*), *Rhodophiala bagnoldii* (Herb.) Traub (*Amaryllidaceae*), and *Zephyra elegans* D. Don (*Tecophilaeaceae*).

The astonishing surprise for ourselves was to find on the front and back covers an excellent photograph (Fig. 1) of a new nationally and locally endemic subspecies we were in the very process of publishing, *A. philippii* subsp. *adrianae* J.M. Watson & A.R. Flores. The image was also repeated inside with accompanying text. Our newly described taxon was at that time in press for *Herbertia* and considered up until then to be an extremely local



Fig. 1. *Alstroemeria philippii* subsp. *adrianae*. A flowering individual of the newly recognised offshore Pacific island populations of this rare Chilean endemic. Comparison shows it as effectively identical with the image from the type locality as published with the protologue in *Herbertia* 63:103, 2009. Its portrait here is taken from the inner fly-leaf of 'Flora de la Reserva Nacional Pingüino de Humboldt', a descriptive overview and taxonomic inventory written by G. Arancio & P. Hara (2007). Reproduced by kind permission of the authors and Ediciones Universidad de La Serena.

spot endemic (Watson & Flores, 2009). Without the slightest doubt their insular plant was absolutely identical to very pale lilac-pinkish tinged forms of our nearby mainland plant in ever visible detail, which was immediately apparent. We were unable to incorporate the data of this extended distribution with our original protologue as it had already gone to print.

Perhaps even more remarkable was the discovery that it occurs on all three islands (Map 1). This not being the least surprise, as Isla Chañaral, the largest, and the one nearest to our mainland type site, is separated from the other proximate two, Isla Damas and Isla Choros, by some 21 km of open sea. In fact Isla Chañaral itself is a further 25 km SW of the type and only known mainland locality. It is difficult to explain this distribution, although possible to draw certain definite conclusions and add some speculation. Wilson (1992) gives a broad outline of the distinct dynamics of maritime island biodiversity, including immigration, competition, evolution, holding capacity and extinction aspects, in particular as related to effects of time, distance from the nearest mainland, terrain area, and range of ecological niches. Investigation by Losos & Schluter (2000)

provides a particularly relevant, more precise and telling statistic: “Within-island speciation exceeds immigration as a source of new species on all islands larger than 3,000 km², whereas speciation is rare on smaller islands”. The combined dryland area of the Humboldt Penguin National Reserve’s archipelago is 8.6 km² (Arancio & Jara, 2007)! We therefore feel on very certain ground to assume *A. philippii* subsp. *adrianae* originated on the mainland as an element of the *A. philippii* s.l. and *A. violacea* complex. Far more puzzling is how it has been distributed to all three of these small, dispersed islands, and why it not only fails to occur along the same latitude of adjacent mainland, but is extremely rare there and restricted to one limited population slightly further north. A reasonable supposition might be that the mainland population was once far more widespread and has contracted severely since, perhaps being close to the point of extinction there now. In conjunction with that, were the islands once joined to the mainland? In that case their alstroemeria populations might be allopatric relicts of a former equally extensive continental distribution. If this is not in fact the geological scenario, it seems reasonable to speculate that seed was conveyed to one island, and then probably in turn to the two others by sea, or more likely bird transportation. Full population may either have been as inter-island, or always from the land. At all events there appears to have been no evident evolutionary change in any of the island populations, which we learn are morphologically identical (G. Arancio, pers. comm.)

There is a fourth island, Isla Gaviota, near the southern pair, but much closer to the coast, only 350 m distant at the nearest point. This locality is not part of the nature reserve and was not surveyed. It would be of extreme interest and scientific value to learn how its flora compares with the other three, and for us as to whether *A. philippii* subsp. *adrianae* is present there too.

The reserve straddles the national Chilean political boundary of Atacama and Coquimbo Regions, with Isla Chañaral administered by the former and the other two islands belonging to the latter. *A. philippii* subsp. *philippii* var. *philippii*, although almost exclusively based in Atacama, is recorded once for Coquimbo (Muñoz & Moreira, 2003). The authors of the book on the reserve considered the islands’ alstroemeria fell within the accepted range of *A. philippii* s.s. variability (G. Arancio, pers. comment), and listed it as such. We therefore record *A. philippii* subsp. *adrianae* here as a new record by them for Coquimbo Region. Nevertheless, the authors classified its conservation status on the islands as scarce and imperilled (Arancio & Jara, 2007).

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Map. 1. The full distribution of *Alstroemeria philippii* subsp. *adrianae* J.M.Watson & A.R. Flores: [1] Type site on Chilean mainland; [2], [3] & [4] Pacific insular populations of the Atacama and Coquimbo Regions.

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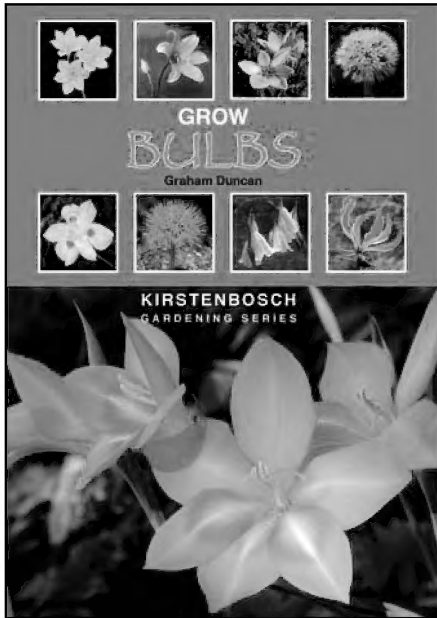
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CONTRIBUTED TO THE CONTINUING SUCCESS OF THE
INTERNATIONAL BULB SOCIETY.**

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PRESIDENT**



BOOK REVIEW

Cameron McMaster

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When I received my copy of Graham Duncan's new book, the second edition of "Grow Bulbs", I was very greatly impressed. This is a fine addition to bulb flora literature. Its full title is "Grow Bulbs - a Guide to the Cultivation and Propagation of the Bulbs of South Africa and Neighbouring Countries". The reason for the extended title is that it includes a few species endemic to Zimbabwe and Mozambique. It is the latest edition to the widely

acclaimed Kirstenbosch gardening series, published by the South African National Biodiversity Institute. The first edition of *Grow Bulbs* was a modest booklet, but nevertheless one of the most popular of the Kirstenbosch series. The new edition is a substantial tome of nearly 390 pages, illustrated by hundreds of high quality pictures, nearly all taken by Graham himself.

Spoilt for choice, beginner-growers of South African bulbs are often at a loss as to which species are best suited to cultivation; *Grow Bulbs* provides practical, step-by-step advice and a selection of more than 400 of the best candidates, including many currently threatened with extinction in the wild, based on experience gained in the Kirstenbosch Bulb Nursery. Written by specialist-horticulturist Graham Duncan, the horticultural attributes of each genus are briefly described, followed by a selection of the best species to grow, each with height, flowering time and distribution details, suitability to garden or container cultivation, and ratings for cold tolerance.

It is prefaced with a chapter describing briefly the 13 families to which bulbous plants belong. It is divided into three parts, covering the Winter rainfall species, the Summer rainfall species and the Evergreen species. The succinct text is fully cross-referenced and illustrated with more than 375

scintillating colour photographs. The book concludes with an extensive list of horticultural references, a glossary of terms, a list of recommended bulb societies and a comprehensive index.

My only criticisms are the inclusion of a number of advertisements at the back which I feel are inappropriate in such a great book. Also a number of species are listed which are probably not available to anyone but the most advanced growers.

In a fine gesture the book is dedicated to the memory Margaret Lilian Thomas (1917-2006), who was an inspiration to Graham and was also founder of the Indigenous Bulb Association of South Africa (IBSA). This is wonderful book with beautiful pictures - a must for everyone involved in growing bulbs.

Note: Available from the Botanical Society Bookshop at Kirstenbosch, Tel: +27 (0)21 762 1621, Fax: +27 (0)21 762 0923, & E-mail: kbranch@botanicalsociety.org.za; and from Silverhill Seeds and Books, E-mail: rachel@silverhillseeds.co.za.

REFERENCES

Title: **Grow Bulbs***

Subtitle: **A Guide to the Cultivation and Propagation of the Bulbs of South Africa and Neighbouring Countries**

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